SCIENCE

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THE INTERPRETATION OF NATURE AND THE TEACHING LABORATORY[1]

There is a universal tendency among mankind to conceive all beings like themselves and to transfer to every object those qualities with which they are familiarly acquainted.—David Hume, 1817.

I

IN all ages human conduct has been largely determined by contemporary opinion, and contemporary opinion by current interpretations of nature. When, for example, the Greeks held that the sun was a god, driving a chariot of fire daily across the sky, it was natural for them to worship and revere the sun as the great giver of light and life. For us moderns, holding, as we do, that the sun is a flaming globe of gas, to do likewise is impossible. Savages, believing that disease is due to demoniacal possession, naturally employ charms for prevention and incantations for cure, while we, holding as we do, that typhoid fever comes only by microbes discharged by antecedent cases of that disease, invoke for prevention disinfection of excreta and protective inoculation, and for cure reinforcement of the vital resistance of the patient. In all cases conduct is determined, consciously or unconsciously, by contemporary interpretations of nature, and we shall find it instructive as well as helpful to review briefly some of those accepted interpretations of the past which for longer or shorter times have occupied the minds of men.

And first we must touch upon those savage and barbarous interpretations character-

[1] An address at Bates College on the dedication of the Carnegie Laboratories of Physics and Biology, January 14, 1913.

istic of the childhood of the race in which everything outside of man is interpreted as essentially manlike in essence, life more or less manlike being assumed to be everywhere—in sea and sky and air and earth—acting in manlike ways and thinking manlike thoughts. This interpretation, the basis of much of our most imaginative speech and poetry, is still fascinating and full of interest.

We need not here raise the world-old questions of realism versus idealism in philosophy. In the childhood of the race, as in the childhood of every one of us to-day, the visible universe was intensely personal, palpitating with a life closely similar to our own and only gradually separated from it by the slow teachings of experience. For precisely as the child of to-day gazes upon kitten, doll or dog and interprets these as charged with a life and character similar to his own, so in the childhood of the race mankind saw in the wind-swept tree, generally at rest but sometimes swayed as by an unseen hand, a living agency to whose touch the awakened tree responds as if from sleeping or dreaming, now by deep sighs or soft murmurs, now by groaning or roaring. And when Lowell in his "Under the Willows" exclaims, "My Elmwood chimneys seem crooning to me," he is simply making modern poetical use of a fireside music which by his remote ancestors would have been interpreted as spirit voices.

It was doubtless one of the greatest forward steps ever made in the emancipation of the human intellect when Pythagoras of Samos before the Golden Age of Greece detected a constant and impersonal relation between the length of a vibrating string and the sound which accompanied it. This discovery of the monochord still stands as the very foundation of acoustics in spite of the fact that it was immediately misinterpreted by Pythagoras and his followers as signifying a universal relation between sound and music and number, and a universal existence of undetected harmony in seemingly silent bodies, an interpretation which lingers even yet in the phrase "the music of the spheres," and has furnished us with many beautiful lines of poetry, such as those of Shakespeare and Milton, and the following much later, from Pope's "Essay on Man":

> If Nature thundered in his opening ears
> And stunned him with the music of the spheres,
> How would he wish that heaven had left him still
> The whispering zephyr and the purling rill.

Longfellow only yesterday referred to

> The Samian's great Æolian lyre
> Rising through all its seven-fold bars
> From earth unto the fixed stars
> And through the dewy atmosphere
> Not only could I see but hear
> Its wondrous and harmonious strings
> In sweet vibration sphere by sphere.
> —"The Occultation of Orion."

And

> even in recent times no meaner a philosopher than Karl Ernst von Baer has asked if there is not "perhaps a murmur in universal space, a harmony of the spheres, audible to quite other ears than ours." (Gomperz.)

Yet Pythagoras lived not long before the golden age of Greece and we do not find even among the Greek nature philosophers many less mystical interpretations.

Students of the history of mathematics refer to three famous mathematical problems of antiquity as "the three classical problems," so called because no satisfactory solution of them could be found; but external nature and inductive science had also their "classical" problems, such as the meaning of day and night, the periodic coming and going of the seasons, the rhythmic phases of the moon, the annual rise of the Nile, the winds, the pulsating tides, all sorts of sounds and music, the origin of man and of the lower animals

and plants, the significance of life, death, generation, sleep and dreams. These were all perennial problems and all insoluble. The men of Greece moved as in a maze, not only ignorant, as we are, of man's origin and fate, but, unlike us, dreading the things around them, since most of these, like the lightning and the hurricane, were not only not interpreted but seemingly might come at any moment to kill or to crush.

At first man stands before the roaring loom of Time, gazing in helpless perplexity at the movements of the infinite shuttles, ignorant of the movements which may be beneficent and of those which may be destructive to him. . . . He has to find his friends and his foes amid the multitude of forces which surround him. . . . The spontaneous activity of his growing intellect urges him to make out some scheme by which the various phenomena may be bound together. He begins to link the known and accessible on to the unknown and inaccessible; he animates the universe; interprets all he sees by all he feels.—G. H. Lewes.

This childlike anthropomorphism, however, failed to satisfy the minds of the more cultivated Greeks, who, having nothing else to fall back upon, retreated from it into a kind of agnosticism or into crude forms of atomism such as that of Democritus. Even the great Hippocrates, while pleading for observation and virtually beginning clinical observation as well as holding to the healing power of nature, was so ignorant of anatomy and physiology and pathology as to be able to offer nothing better as a theory of disease than his well-known suggestion of the four humors, of which the sole merit—though at that time a very great merit—was that it focused attention upon the patient rather than on priest or temple or bloody sacrifice; that is to say, on the disease itself rather than on some ancient dogma. Empedocles, it is true, is believed to have used natural means to forestall disease when he cut down the hill behind Girgenti and drained the malarial marshes of Selenunti, the parsley city. Aristotle, too, for the most part seems far away from anthropomorphism in most of his thought and work, but while all the middle age regarded him with Dante as "the master of those who know," Lewes has truly said:

It is difficult to speak of Aristotle without exaggeration; he is felt to be so mighty and is known to be so wrong. . . . His influence has only been exceeded by the great founders of religions; nevertheless, if we now estimate the product of his labors in the discovery of positive truths, it appears insignificant when not erroneous. None of the great germinal discoveries in science was due to him or his disciples.

The Roman period was practically sterile as to any helpful interpretations of nature, the great work of Lucretius being for the most part an amplification of that of Epicurus; while the triumph of christianity and, later, of Mohammedanism over the Roman world, or parts of it, merely imposed upon it oriental interpretations which by substituting few gods or one for the multitudes of Greek mythology, simplified without wholly depersonifying nature. It may well be, however, that the introduction of the Hebrew Scriptures into the western world afforded a real relief from the overhumanized and top-heavy interpretation of the Greeks and Romans. What a cool refreshment follows, for example, a verse like this taken from those Scriptures: "The wind bloweth where it listeth; thou hearest the sound thereof, but canst not tell whence it cometh or whither it goeth." Here is no excessive anthropomorphism. The wind and its blowing do not strike us as interpreted differently from our explanations of to-day. Sound is personified, but at the same time we have a frank admission of ignorance as to its origin and fate. As opposed to the theory of Æolian origin and the assumption of personality we have

cool, calm abstraction which may well have been grateful even to Greeks weary of a refined anthropomorphism.

All through the dark and the middle ages interpretations of nature more or less anthropomorphic and childlike remained common. Shakespeare is deeply tinged with them, while Francis Bacon, catching cold and dying from his famous experiment on the cold storage of poultry, stands out as even more original for this than as the author of the "Novum Organum." It is the glory of the Renaissance that it began the age of experiment. Hippocrates had displayed something of the modern spirit, but he was born too soon. Roger Bacon had it in fuller measure and paved the way for Gutenberg and Copernicus and Leonardo da Vinci and Columbus and Gilbert and Magellan. In the sixteenth and seventeenth centuries for the first time in history a succession of ardent students investigated, and in our modern fashion interpreted, the external world.

Thenceforward events moved rapidly. Galileo and Kepler were followed by Harvey and Boyle and Newton; the telescope, the thermometer, the barometer and the compound microscope came into being; scientific societies sprang up and the modern order began. Old interpretations gradually passed away. All things gradually became new. Matter and energy in myriad forms and combinations replaced the gods of old, with the result that since the time of Newton man has looked out upon the world about him, without fear and as if upon the face of a friend.

II

Teaching must forever recapitulate and epitomize the achievements of the race. Consciously or unconsciously it acts along the lines of the biogenetic law. Beginning with the child who thinks as a child, it offers to him fairy tales in which nature is personified and encourages (note the word) him to see in things about him a life akin to his own. Then comes the awakening, when Santa Claus becomes a benevolent myth and dolls are discovered to be stuffed with sawdust. Next follows the slow recognition of earth and sky, of sun, moon and stars as inanimate objects, and finally the discovery of law and order in the universe.

To facilitate and abbreviate this process and to ensure a sound result, teachers of natural philosophy in the old days performed experiments before their classes. Then came the teaching laboratory, not so much as a workshop as a place for demonstration, experiment and research. The real workshop or laboring place is oftenest none of these, but simply a space in which routine operations of one or various kinds are done over and over again for profit, as, for example, in a shoeshop, a box factory or a cotton mill. The college laboratory of physics and biology is not, and never should be, this sort of workshop. It is rather a place where such demonstrations of principles or processes are made as shall serve for education rather than commerce. A place where old and perhaps famous experiments, chosen for their educational value, can be performed with and by successive classes, and where investigations that promise to yield new or improved results can be prosecuted under favorable conditions. It supplies the room, the apparatus, the power, the raw materials and especially expert and wise guidance, by means of which a personal knowledge of nature can be gained in orderly fashion, and a fundamental and lasting training effectively acquired. It is an indispensable tool or instrument with which to gain rapid and intimate personal acquaintance with nature and the laws of nature. It should

afford for the student a kind of moving picture of the progress and the conquests of science. With the vast extension of the field of knowledge during the last three hundred years it has become impossible for any one to grasp the enormous quantity of facts at our disposal. And yet the child, instead of beginning where his father left off, must begin exactly where his father did. Hence the urgent need of careful choice of facts, choice of experiments, of apparatus and of educational machinery if he is to go in one short life even a little further than his father went. In short, the modern college laboratory is not so much a workshop as a school room, in which selected natural phenomena, facts and processes may be conveniently, rapidly and successively demonstrated and enforced. It should provide at the outset an epitomized, easy and rapid recapitulation of the slow and laborious discoveries of the past, and thus somewhat resemble the museum of art or natural history which likewise affords examples or models of past achievement. That it is essentially dynamical while the museum is statical alters nothing of its recapitulative educational function; that it must necessarily compress the long history of the past into a short time, so that it shall give only an epitome of human progress, is inevitable, and if well done is not merely unobjectionable but desirable.

We hear much nowadays of economy and efficiency in education, as elsewhere, but we have yet to learn that true efficiency in education is not to be measured so much by the number of hours devoted by the teacher to his pupils or to his laboratory or by the time spent by scholars upon their tasks as by the wisdom of his decisions what to teach, and in what order, and especially what to omit. It is easy, though never wise, to seek to cover the whole field, but it is not easy to discover which phenomena, which experiments, which demonstrations are most worth while, most productive of genuine learning, of good judgment, common sense, real wisdom and power.

But whatever our endeavor, this must always be—consciously or unconsciously—an attempt to lead the student on to a sound and true interpretation of nature. And surely the modern interpretation, as we seek and find it in laboratories like this one which we dedicate to-day, is objective rather than subjective. It begins with the rigorous abnegation of ourselves, and a calm survey of the world about us, charged with impersonal matter. The lightning plays about us with the same energy as in Homeric days, but it is no longer Zeus who sends it forth. The waves fling themselves upon our rocky shores to-day precisely as of old they beat upon the islands of the Ægean, but we do not see in them, as did the Greeks, the fury of Poseidon. We see only an almost irresistible pressure of the atmosphere in motion. For us the winds are not the messengers of Æolus, but only lifeless gases caught up and dragged by the swiftly spinning earth or seeking an equilibrium upset by local expansions or contractions due to heat or cold.

Is there, we may well inquire, any more important function for modern scientific education than to interpret, in a laboratory like this which is dedicated to-day, to earnest and eager youths such as the state of Maine sends to her colleges, that nature of which man himself is at once the crowning glory and the principal problem! To inform, to instruct, to adjust—if possible even to attune—the thought, the opinion of youth; to correlate its activities to its environment so that its internal relations may become usefully, efficiently and

happily adjusted to those external relations which were never more complex or more exacting than to-day,—this is our problem. We hear at present much of wars and rumors of wars, and a new social heaven—or at least a new earth that is to become a new heaven. But the universe moves on in its appointed ways. The sun and the moon and the stars and the seasons and day and night are with us, as of old. Plants and animals only slowly change their nature, and mankind is born and lives and dies much as it has always done. Art, to be sure, has become vastly longer, but life is still nearly as short as ever and relatively to the things to be seen, to be learned and to be done, infinitely shorter. The fundamental problem of all education, namely, preparation for life, is therefore no less, but rather infinitely more, important.

But with the aid of laboratories like this, generously furnished by lovers of their kind, in which wise teachers, themselves models of devotion to truth and scholarly living and endeavor, by means of examples, epitomes and recapitulations of the great experiments and discoveries of the past, shall enable their pupils to appropriate forever to themselves and to the service of man the accumulating wisdom of the ages, we may go forward with a cheerful courage. Nor does it seem too much to believe that an interpretation of nature which has robbed it of most of the terrors which it possessed for primitive man and has made it increasingly serviceable to the race, will long endure.

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THE FITNESS OF ORGANISMS FROM AN EMBRYOLOGIST'S VIEWPOINT[1]

I am glad to accept an invitation to address this club, for I believe that it is an excellent custom, indeed, almost necessary in these days of specialization, for a biologist to look at his problems now and then from others' points of view and to be brought into contact with men working on quite different aspects of life than his own. The same fundamental problems face all workers in the biological field, be they ecologists, structure-workers, process-workers, breeders, or, I might add, workers in the broad field of the medical sciences, for I believe that the clinician fully appreciates that the problems of health and disease are, on one aspect at least, problems of life and that medicine on its science side belongs in the broad field of biology. It is the unitary character of life and life phenomena that binds us all together and creates bonds of common interest and the goal toward which we all must strive, whether we know it or not—if the minor problems which we attack are correctly solved—is the explanation of life.

It is a goal which perhaps we may never reach or whose outline at some future time will be made out in but crude and hazy form, and yet it does us good ever and anon to pause in our detailed work of analysis and technique and turn our eyes in the direction we believe it lies and to ponder on the road before; it helps us I believe toward a clearer appreciation of the setting of the petty problems that immediately confront us. Perspective is too apt to be lost in the close scrutiny of high specialization. In such a contemplation from afar of the end-problem of the biologist, some, overwhelmed by what lies between, believe it unattainable; and others proclaim that the solution is close at hand; one sees in the intricacies of life evidences of a vital force while for his fellow-worker the explanation is to be wrought out in terms of physics and chemistry alone. For each the attitude of mind that will color his speculations will be compounded out of his personal make-up, the daily routine of his work and the time and concentration that he has devoted to it. The field naturalist easily inclines toward vitalism; the biochemist, perhaps, is biased toward a physicochemical interpretation; the structure-worker —and in this group I would place myself—in

[1] Talk before the Agassiz Club of Cornell University, February 24, 1913.

more or less intimate contact with both fields, may be drawn toward the one or the other camp.

In the interpretation of life phenomena, we can not, of course, escape from the domain of physics and chemistry; the living body is material, and the fundamental physical laws of the conservation of matter and energy hold there as in the inanimate world. In the transformations that take place in organisms, there is no evidence whatsoever known to me of or the least indication that new matter has appeared or new energy been created. We are constrained therefore, if we must postulate a vital force, to conclude that it is a new form of energy developed out of the other energy forms and transformable into them again. Since we know nothing about such a special life form of energy, but only the energy of inanimate matter, there has always seemed to me no value in its assumption, since the analysis must always proceed from the known to the unknown and be expressed in terms of the physics and chemistry of the organism. If in course of time it becomes apparent that another energy form exists in living organisms, it will then be time enough to discuss it; for the present I do not believe it helps to introduce it.

In all analysis of life phenomena, very fundamental it seems to me is the analysis of *life conditions,* those absolutely essential for its manifestation, and you will, I know, pardon my introducing here so elementary a matter as their enumeration. They are: (1) Food-stuffs, *i. e.,* the necessary chemical conditions; (2) oxygen; (3) water; (4) heat, *i. e.,* the adequate temperature; (5) pressure. Out of these, together with a few more that rest upon them as a basis—(6) protection, of diversified forms; (7) elimination of useless material; (8) formation of new individuals as centers of organic transformation—are compounded the fundamental life activities, of the higher organisms at least. It is hardly necessary to insist upon the broad application of the above thesis. Following through the sum total of the activities of an organism—and I would include its structure as but the partial expression of these same activities—untangling in your analysis the complex that they form you come back to the fundamental categories of life manifestation enumerated above and the conditions that underlie them. There is, of course, nothing fundamentally different in the manifestation of life under the given necessary conditions and a chemical or physical reaction. To take a simple example, the rusting of iron. Given the necessary conditions, namely, the presence of water, oxygen, some acid, I am told, such as carbonic acid, and of course iron, under an adequate temperature, and the reaction will proceed at a given rate. Under somewhat different and more complex conditions, the presence of some other acid or salt, and with less pure iron, the reaction will proceed more rapidly. But I am venturing on rather dangerous ground and must withdraw.

There are two aspects of life manifestation which I desire to mention and which will introduce the subject that I chose to discuss with you. The first of these is the continuity of life and all that it includes—growth and reproduction. This in itself would possibly be regarded as more intimately characteristic of life, but I believe that if we were to stop to analyze it out, we would find nothing distinctive in mere continuity. One might, I think, find illustrations of purely physico-chemical reactions taking place in the earth's crust to-day that have been proceeding since its foundations. It is that in organisms *insuring* the continuity which is peculiarly biological. The molding of the life activities of organisms to a more or less specific environment supplying the necessary life conditions so that environment and organism constitute an interrelated system of more or less complexity, is the second aspect I made reference to, and adaptation[2] appeals to me as a second very fundamental fact in biology. Of the truth of this and the great diversity of patterns in which life activities and environment are interwoven in different organisms, you doubtless know better than I who have largely only

[2] The term is employed in the broad sense, and as a passive instead of active noun.

second-hand knowledge of ecological relations. The constancy as well as the complexity of each pattern is the striking thing.

I trust you see with me that there is nothing in the mere element of *fitness* that is peculiar to life. Any chemical reaction requires a fitness of conditons, if we choose to use the word. It is the *pattern* that embodies elements more peculiarly biological. The pattern in the world of living things at the present day is complex indeed, but particularly so in the higher animals, in whose evolution there has been established a complexity of pattern in which the woof colors of organism more and more dominate the warp of outside environment, or, to abandon the metaphor, in the thought of Professor Matthews at the recent symposium on Adaptation, the highest step in the perfection of adaptation has been reached by making the organism superior to, adapted to, all environments; or, differently put, in the taking the immediate life condition environment within the organism itself.

And now we come to the critical point in our attitude toward adaptation. In the use of such terms as fitness, adaptation, control of environment, we invoke teleology. The objection has been raised, and I believe rightly, that to an analysis in terms of cause and effect any consideration of use, purpose, or aim must be extraneous. We should in all instances differentiate between the explanation of the phenomena and whatever teleological significance may attach thereto. The analysis may perhaps not necessarily be directly in terms of matter and energy, but it can take no cognizance of a teleology as a link in the chain. I should like to discuss this aspect of the adaptation problem at some length, but time is inadequate. Here, however, we stand at the branching of the road, we have a choice before us. (1) Either there must be found some substitute for the term adaptation that will avoid the teleological element, or (2) accept a pervading life force in all organisms, animal or plant, whose highest development appears in human consciousness and intelligence, a mind force coextensive with the matter and energy of organized matter. Some day we may be compelled to postulate a directive principle such as the entelechy of Driesch, but I do not believe its assumption at the present stage of knowledge and analysis is necessary or helpful. Personally I believe that the right road leads toward an ultimate analysis and recasting of what we mean by adaptation. The recasting, however, must needs strike deep: ideas of cooperation of organs with specific functions, expressing a division of labor, belong in the same category. The unitary character of the entire life processes and the structure as but the material expression of these is it seems to me the keynote that must be struck and emphasized in all our analyses of life phenomena on the side of explanation in the terms of cause and effect.

And yet I think that the belief prevailing in some quarters that all in life may be explained in terms of physics and chemistry errs equally on the other side. Life in an organism to-day is like a tapestry in which the threads of warp and woof are woven into a pattern of exceeding intricacy and delicacy whose weaving has been going on since the beginnings of life. You may analyze the threads of process as they run in and out to-day in terms of chemistry and physics, it may be, but the pattern stands as a history of the past and the weaving is still largely a secret of the ages. The pattern is the problem of evolution, and inheritance if you will. For me, the pattern in which the life activities of any organism are expressed is threefold, expressed by the words adaptation, form, consciousness. No one of these can I conceive as being explainable in physico-chemical terms. Granting that some day you may know the full chemistry (or physics) of the formation of secretin and how it causes the secretion of the pancreatic juice, there will still remain unexplained the adaptation. Full knowledge of the gross and fine anatomy of the face, the morphogenesis and histogenesis of its development and analysis of the physico-chemical processes underlying these, would, it seems to me, leave still unexplained the cast of feature. Even if we assume that future workers will be able to un-

ravel the complex histological tangle of the cerebrum and analyze the physico-chemical processes that take place therein when it is active, consciousness will remain incomprehensible on such a basis. I have been told of a man who was working on the physical-chemistry of instinct. I feel sure our psychological friends would reject with laughter such a thesis; they might perhaps accept it if it were worded as the physico-chemical processes under lying instinct. You can not analyze the pattern by analyzing the component threads, although that might help you in the end toward fully understanding the pattern. I do not believe you can analyze the pattern of the life activities in an organism, including of course its "behavior," by analyzing the threads of process that compose it. Try it, and I prophesy that failure will result, or you will resort to the assumption of an autonomous vital principle, as Driesch has done. You can not analyze phenomena of one category in terms of those of another. It is possible of course that in time we shall know so much of the activity pattern of organisms and how it was evolved that we shall be able to solve the problem of life, but I do not believe the explanation is so close at hand as some would have us believe, and perhaps we shall never know from inability to unravel the past.

You may gather from what I have just said that so far from regarding those of you working along ecological lines, as I know some of you are, as straying from the road that leads toward the explanation of life, I would consider you as pursuing lines of work in a field peculiarly biological for which I know of no broader and better term than that proposed by Minot—bionomics. My only comment is that such work should be analytical and not merely descriptive, and you can not neglect the texture of the fabric in tracing the pattern.

I have now, I fear, gone far afield in laying before you my attitude toward adaptation and have little time in which to present one or two aspects of the subject that are of interest to the embryological worker and to you as members of a peculiarly bionomic club, if you will let me use the term. If in the following I speak of adaptation, fitness, function, purpose, I shall do so for simplicity's sake to avoid complicated paraphrases, using them as pattern terms solely. As one who is particularly interested in the analysis of structure, I can not but feel the all-pervading element of fitness—adaptation—in structure, and the importance of having a clear conception of what it stands for when interpreting structure. Whatever portion of the organism you select for critical examination offers illustration many-fold, so that I have been puzzled that the existence (not interpretation) of adaptation can be questioned. There are, however, structures in the vertebrate body, as you doubtless know, in which adaptation does not stand revealed; I refer to vestigial structures which, however, stand for adaptations, not present but past, and may be divided into two somewhat distinct groups, of which I will venture to present one or two illustrations. Again I will recall familiar facts to you, from a rather different point of view, perhaps.

The past history of organisms is reflected, however imperfectly, in their development. Past adaptation patterns, no longer applicable, continue over. They may, or may not, play a part in meeting the life condition complex with which that organism is interwoven. The quality of fitness in them may exist or appear to be quite lacking. Numerous illustrations may be chosen from the embryology of vertebrates which are thoroughly familiar to you. The development of the branchial chamber, expressing a fundamental adaptation pattern in the lower vertebrates, subserves no such useful purpose in the higher forms. In connection with it come certain intensely interesting structures in which adaptation may or may not be revealed. I can not appreciate the functional importance of the thymus coming from the third branchial pouch, nor of the similar structure occasionally developing from the branchial chamber farther back. To me the tonsils have no deep hidden part to play in the bodily economy but, useless and in some cases detrimental, stand for a tiny portion of an adaptation that is past. No specific functions have been revealed; but in saying this,

do not understand me to say that these structures are not without a possible effect in the organism. The mesonephros of mammals likewise represents an important adaptation of the past, but Felix has once and again pointed out that evidence of an excretory function is lacking. But these illustrations will suffice. As a record of the past history of the race, they stand as a testimony to the very change in adaptation that the organism has undergone with the progress of time and evolution. As such they afford valuable clues and are thus of taxonomic value.

In the second group I include those adaptations that exist or appear in the course of development to meet the life conditions peculiar to that period. These structures introduce complexities in development. They are present at one period of the life cycle and pass away with changed conditions. Where traces of them remain, they are like the vestigial structures of the first group, a record of past adaptations, but in the individual history and not primarily that of the race. As an example, the Kiemenreste (gill-remnants) of frogs and toads stand as a record of the early adaptations of the frog in its larval period. No function can be assigned them; they appear to have no past history in the race. Again let me repeat I do not say that they may not be without effect in the organism. The most noteworthy instances in this group of structures of interest to the vertebrate embryologist are the fetal membranes, structures developed out of the animal's body (essentially) mainly for the protection, nutrition and respiration of the individual during the early period of its ontogeny and subsequently discarded when no longer needed. Since they are outside the body, they are not continued as vestigial structures; only insignificant folds and so-called ligaments remain as more or less useless remnants.

Such transient adaptations in the individual life history have, of course, been evolved and perfected in the evolution and share with those of the first group a taxonomic value, but with this difference: such adaptations to meet very specific needs at a specific period in the individual's life should, I believe, be used with caution. Let me give the two examples that have impressed me most.

In the development of the fetal membranes of mammals a very marked variation in the arrangement in the different forms occurs. In general the plan of development and relations appears to be broadly characteristic of the different orders. In perhaps the majority the amniotic cavity is formed by folding essentially as in the reptiles and birds. In certain of the rodents, chiroptera, insectivora, and probably primates, however, the amniotic cavity appears precociously in the midst of the ectoderm or trophoblast and only subsequently do the typical structure and relations of the amnion become established. An eminent embryologist of Europe, Hubrecht, to whom are due many of the facts of the early development in these forms, concluded that this method of formation of the amniotic cavity, by dehiscence, is the primitive type and therefore decides in favor of an origin of the mammals from amphibian-like forms. This method of amnion formation appears, however, closely correlated with the method of implantation of the ovum and placenta formation, and inasmuch as the type of placentation represented is obviously the highest and most direct the primitive character of amnion formation by dehiscence may be seriously questioned. The uselessness of such a character for taxonomic purposes is further illustrated by the fact that in but one of the four groups where it occurs is it apparently constant, but amnion formation by folding is found as well in certain of the forms.

My second illustration of the questionable character of such ontogenetic adaptations as clues to genetic relations is the tadpole stage of frogs and toads. The structural relations of the larval organism depart in detail so widely from the typical relations and are so obviously correlated with the immediate life conditions that one is justified, I believe, with Spemann and Versluys in regarding the adult as probably standing nearer the "ancestral line." Founding broad genetic conclusions from the conditions in the tadpole may be done only with caution and reserve. The per-

version of fundamental relations in the larva is well illustrated in the development of the middle ear and sound-transmitting apparatus where my personal interest has centered.

Thus the embryologist in attempting to explain development encounters illustrations of the formation of apparently non-adaptative structures and structures whose adaptative value has apparently been lost. The idea of adaptation must be ever present with him and yet he must avoid the assumption of a "function" for all things, or seek "fitness" as the key to the interpretation of structure. The field or work for him is first of all the analysis of the underlying developmental processes in which adaptation is portrayed. There are, however, always the two aspects, pattern and texture, in life activities.

Illustrations of apparently non-adaptative structures which apparently never are or were adaptative will doubtless occur to you, many of them correlated with sex; others apparently useless and seemingly a pure exuberance of growth and behavior. These I can not discuss; they lie outside my field. They emphasize again that the secret for them as for adaptation lies wrapped up in the complexity of life processes with the obscure and prolonged evolutionary history involved, and our only hope lies in analysis.

B. F. KINGSBURY

THE FINAL EXAMINATION OF SENIORS IN AMERICAN COLLEGES

WHETHER seniors at the end of their college course should be required to take examinations at the same time as other students, or several days or weeks earlier, or whether they should be excused from examinations altogether upon the basis of their term standing, is a problem which is not infrequently up for discussion. While one may hardly hope to settle the matter absolutely, to know the practise in different institutions throughout the country may not be without value.

Early in May, 1912, I sent out a postal questionnaire to all the institutions listed under the head of "Universities, colleges and technological schools for men and for both sexes" in the Report of the Commissioner of Education for 1909, which was the latest volume accessible to me at that time. There were but two questions asked, viz., "Do the seniors in the collegiate department of your institution take their final examinations in the spring term, or second semester, at the same time as, or two or three weeks earlier than, the rest of the students?" "Are some of the seniors excused from the final examination upon the basis of their high average, 85 per cent., 90 per cent., 95 per cent., during the spring term, or second semester?" Of the 493 institutions to which postals were sent, 347 replied, and those replies throw at least some light upon the problem.

The simplest method of dealing with this material is to take the undifferentiated list of institutions in its entirety. Of the total number, 493, 70 per cent., were heard from. Of these, 167 require the seniors to take their final examinations at the same time that the rest of the students do, while 154 set the senior examinations at an earlier date. There were, also, 26 replies which were not definite. This majority of 13, while not great, becomes more significant when one considers the variety which prevails among the other institutions. The date for these earlier examinations varies from two or three days before the regular examinations to seven or eight weeks. The tendency, however, is to have them scheduled one or two weeks earlier, as is shown by 68 and 46 postals, respectively.

The following tables are in the main self-explanatory.

TABLE I

Institutions at which Final Examinations for Seniors are Scheduled Earlier than for Underclassmen

Two or three days earlier	3	Two or three weeks earlier	19
Five days earlier	1	Three weeks earlier	8
Ten days earlier	3	Three or four weeks earlier	1
One week earlier	68	Four weeks earlier	1
One or two weeks earlier	2	Seven or eight weeks earlier	1
Two weeks earlier	46	Scattering[1]	1
Total	123	Total	31

[1] This term designates a card which indicated that some of the examinations are earlier, but did not specify definitely.

TABLE II

Distribution of the Institutions of Table I. according to the Census Divisions

North Atlantic	31	South Central	13
South Atlantic	28	Western	13
North Central	69		
		Total	154

TABLE III

Distribution of all the Institutions to which the Questionnaire was sent

North Atlantic	91	South Central	77
South Atlantic	82	Western	46
North Central	197		
		Total	493

TABLE IV

Number of Institutions Heard from in each Division

North Atlantic	72	South Central	38
South Atlantic	51	Western	35
North Central	151		
		Total	347[2]

TABLE V

The Percentage of Institutions Heard from in each Division

North Atlantic	79%	South Central	49%
South Atlantic	62%	Western	76%
North Central	76%		

TABLE VI

Distribution of the Institutions that require Senior Finals at the Same Time as for Other Students

North Atlantic	38	South Central	22
South Atlantic	21	Western	18
North Central	68		
		Total	167

If we compare Tables II. and VI., it is evident that the two methods of arranging senior finals run rather evenly. The low percentage of returns from the South Atlantic and South Central divisions, as shown in Table V., makes any inference decidedly hazardous. That the ratio in the other divisions would remain about the same, were all the remaining institutions heard from, is likely because of the high percentage of replies obtained from those sections. This part of the problem, then, remains rather indeterminate, when the undifferentiated list of institutions is treated in this simple way.

[2] This number, 347, represents all the postals returned. Twenty-six of them were too indefinite for use on this first problem. Most of them, however, are usable on the second problem.

If we turn, now, to the second problem, viz., excusing from examinations, we find that the alignment of the different institutions does not remain the same. About one half of those that schedule the senior finals early also excuse from the finals altogether provided the term work is satisfactory, and somewhat less than a third of the other group follows the same practise. The percentage accepted as satisfactory ranges from 65 per cent. in one case to 95 per cent. in several others. The majority of the institutions which approve this practise make either 85 per cent. or 90 per cent. the sufficient grade. In Table VII. the distribution of these institutions is given.

Table VII. shows that 121 institutions, or slightly more than one third of all that were heard from, are accustomed to excuse seniors from final examinations in the last term or semester upon the basis of their term or semester standing, or altogether as is true in a few cases. Since 70 per cent. of all the institutions in the country responded to the questionnaire, it is likely that the same ratio would be maintained if all reported. It is also very evident from this table that there is a greater tendency to excuse from examinations among the institutions of the North Central section than elsewhere, since about one half of all the institutions of that sort in the country that replied are located in that section, while only 39 per cent. of all the institutions of the country are in that division. Still further, since 76 per cent. of all the institutions of the North Central division responded to the inquiry, it is likely that this high average prevails among the other institutions of this locality that were not heard from. This is a more definite result than that obtained with reference to the first question by the application of this simple method to the data in hand.

Another method of dealing with the data confirms the result just stated, and yields

TABLE VII

Distribution of Institutions that Excuse Seniors from Final Examinations

	North Atlantic						South Atlantic						North Central					
	Less than 85%	85%	90%	More than 90%	Various[4]	Totals	Less than 85%	85%	90%	More than 90%	Various	Totals	Less than 85%	85%	90%	More than 90%	Various	Totals
Institutions which otherwise require finals at SAME TIME		3	3		3	9			1			1	2	9	9		7	27
Institutions which otherwise require finals ONE WEEK EARLIER		4			5	9	1		2	2	2	7			1	1	4	6
Institutions which otherwise require finals TWO WEEKS EARLIER					1	1		1			2	3	1	2	3	1	4	11
Scattering[3]					1	1	1	1	1		2	5	1	5	5		6	17
Totals		7	3		10	20	2	2	4	2	6	16	4	16	18	2	21	61

	South Central						Western						Totals of all Divisions
	Less than 85%	85%	90%	More than 90%	Various	Totals	Less than 85%	85%	90%	More than 90%	Various	Totals	
Institutions which otherwise require finals at SAME TIME		2	1	1		4		1	2	1	1	5	46
Institutions which otherwise require finals ONE WEEK EARLIER					1	1	1			1		2	25
Institutions which otherwise require finals TWO WEEKS EARLIER			2			2			1		1	2	19
Scattering[3]		1	2		1	4		1			3	4	31
Totals		3	5	1	2	11	1	2	3	2	5	13	121

rather definite information in connection with the practise of setting senior finals at an early date.

The list of institutions given in the "Report of the Commissioner of Education"[5] is complex. If we analyze it and put the state universities in a group by themselves, state colleges by themselves, colleges and universities on private foundations by themselves, and so on, and then get at the annual income of each institution and make corresponding subgroups, much more information is elicited.

It is, of course, not easy to arrange these institutions in income groups. For this purpose, I used the Report of the Commissioner of Education for 1909 and for 1910.[6] A very elaborate treatment would require a study of each institution through the last ten or twenty years. Even then there would be difficulty in determining what group an institution should be placed in because of the fluctuations of income due to growth or decay, increase or decrease in tuition, and the varying amounts yielded by invested funds. The two reports just referred to, however, seem to furnish sufficient material for the purposes of this investigation.

In determining the group to which an institution belongs, I considered the annual income as made up of "tuition and other fees for educational services," the amount obtained from "productive funds," and the amount gained for "current expenses" from "city, state or national government, or private benefactions." It is true that this represents only

[3] This term is used to designate those institutions which schedule senior examinations at other dates than just one or two weeks, as indicated on Table I.

[4] The term "Various" is used to include excusing from examinations at the option of the professor, with or without a definite percentage, and a number of other ways which hardly needed to be presented in detail, while the total of this and 90 per cent. are the preferred satisfactory grades.

[5] Report for 1909, pp. 900–924.

[6] Report for 1909, pp. 961–977. Report for 1910, pp. 943–961.

rough work, and yet when the same test is applied to each institution for two successive years the results can not be far wrong. Table VIII. gives these results in simple form for those institutions which replied to the questionnaire, arranged according to their attitude to the first question, and the institutions not heard from in a column by themselves. The institutions with no incomes listed in these two reports are of course not entered. This accounts for the discrepancy between the total 461 and the 493 to which postals were sent. These income groups, too, I worked out especially in connection with the colleges and universities upon private foundations, since it is with these that the problem seems to be most acute.

TABLE VIII

Educational Institutions according to Groups

		Examinations Scheduled for Seniors: At Same Time as for Other Students	Examinations Scheduled for Seniors: Earlier than for Other Students	Examinations Scheduled for Seniors: Scattering[7]	Institutions Not Heard From	Totals
Schools of technology		4	5	1	5	15
Agricultural schools		1	11	1	10	23
State universities		17	13	3	8	41
State colleges		2	2		1	5
State schools of mines					4	4
Military and naval institutions		2			4	6
Universities and colleges on private foundations with an annual income of	$100,000 or more	32	14	2	2	50
	$ 50,000 to $100,000	19	17	3	6	45
	$ 25,000 to $ 50,000	17	32	5	25	79
	$ 5,000 to $ 25,000	65	50	10	59	184
	Less than $5,000	2	1		6	9
Totals		161	145	25	130	461

From this table it is evident that a majority of the state universities and of the colleges and universities on private foundations with an annual income of $100,000 or more, follow the practise of requiring the seniors to take their final examinations at the same time as the rest of the students. Still further, of all the state universities, only four have an income apparently under $100,000 a year. One of these belongs among those with senior examinations at the same time as for other students, two among those favoring an earlier date, and one among those not heard from. Combining these results, we get 48 institutions with an annual income of $100,000 or more favoring examinations for all students at the same time, and 25 favoring an earlier date for senior finals. The practise of these institutions seems to be decidedly in favor of the former. It is of importance, too, to note that all of the colleges and universities in the country on private foundations and belonging to this group were heard from except two.

This table also shows that the practise of having senior finals at an earlier date is almost equal to the other method among the colleges and universities with an annual income of from $50,000 to $100,000, and that it reaches a majority of almost two to one among the institutions with an income of from $25,000 to $50,000 a year, or 40 per cent. of all the institutions of that class in the country. In the next lower income group, the ratio shifts back into approximate conformity with the highest income groups.

The distribution of these institutions according to the census divisions is rather suggestive in places. We need consider only the state universities and the groups of institutions on private foundations, except the lowest.

TABLE IX

Distribution of State Universities

		North Atlantic	South Atlantic	North Central	South Central	Western	Totals
Final examinations scheduled	For all students at the same time	2	2	10		3	17
	For seniors earlier		3	3	3	4	13
	Scattering[8]				1	2	3
Institutions not heard from			1	1	4	2	8
Totals		2	6	14	8	11	41

[7] "Scattering" means that the postals did not indicate clearly whether the examinations for seniors occurred earlier or not.

[8] "Scattering" means in Tables IX. to XIII. that the postals were indefinite on this point.

From Table IX. it is evident that in the North Central section where the state universities are most numerous, and each of them has an annual income of more than $100,000, there are 10 out of 14 that schedule the final examinations for seniors at the same time as for the rest of the students. Tables X. and XA, also, show that in the North Atlantic section where the colleges and universities of the highest income class are most numerous, 18 out of 28 follow the same practise, and 10 out of 12 is the ratio of these same institutions in New England. These institutions are, presumably, especially well equipped and committed to the highest educational ideals. Or to put the matter differently, 17 out of 41, that is, nearly a half of all the state universities in the country, and 32 out of 50, that is, much more than a half of all the colleges and universities of the highest income, set the senior finals at the same time as for the other students. This is certainly significant.

In Table XI. the situation is about evenly balanced, although the general results seem to be more in line with the two preceding tables than out of harmony with them.

If we turn, now, to Table XII., it is evident that about half of all the institutions of this class are in the North Central section, and that slightly more than a half of these set the senior finals at an early date. Or to put the matter differently, about two thirds, 20 out of 32, of all the institutions in the country of this class that reported this practise are in this North Central section.

TABLE X

Distribution of Colleges and Universities on Private Foundations with an Annual Income of $100,000 or More

		North Atlantic	South Atlantic	North Central	South Central	Western	Totals
Final examinations scheduled	For all students at the same time	18	4	7	1	2	32
	For seniors earlier	10	1	2	1		14
	Scattering			1		1	2
Institutions not heard from				1	1		2
Totals		28	5	11	3	3	50

TABLE XA

Special Analysis of the Distribution of Colleges and Universities on Private Foundations with an Annual Income of $100,000 or More in the North Atlantic Division

		New England	New York	New Jersey	Penna.	Totals
Final examinations scheduled	For all students at the same time	10	6		2	18
	For seniors earlier	2	2	2	4	10
	Scattering				1	1
Institutions not heard from						
Totals		12	8	2	7	29

TABLE XI

Distribution of Colleges and Universities on Private Foundations with an Annual Income of from $50,000 to $100,000

		North Atlantic	South Atlantic	North Central	South Central	Western	Totals
Final examinations scheduled	For all students at the same time	7		8	2	2	19
	For seniors earlier	7	1	6		3	17
	Scattering	1		1		1	3
Institutions not heard from		3	1	1	1		6
Totals		18	2	16	3	6	45

TABLE XII

Distribution of Colleges and Universities on Private Foundations with an Annual Income of from $25,000 to $50,000

		North Atlantic	South Atlantic	North Central	South Central	Western	Totals
Final examinations scheduled	For all students at the same time	4	2	5	4	2	17
	For seniors earlier	3	6	20	2	1	32
	Scattering		1	4			5
Institutions not heard from		5	5	10	4	1	25
Totals		12	14	39	10	4	79

Table XIII. does not yield quite such distinct results as Table XII. and yet it points in about the same direction. About one half of all the institutions in this class are in the North Central section, and nearly one third of these have the senior finals early. Still further, 29 out of 50, about three fifths of all

the institutions of this class that reported early finals from all parts of the country are in this North Central division.

TABLE XIII

Distribution of Colleges and Universities on Private Foundations with an Annual Income of from $5,000 to $25,000

		North Atlantic	South Atlantic	North Central	South Central	Western	Totals
Final examinations scheduled	For all students at the same time..	4	8	36	10	7	65
	For seniors earlier.	5	10	29	5	1	50
	Scattering........	1	1	5	2	1	10
Institutions not heard from...		5	12	21	19	2	59
Totals.........		15	31	91	36	11	184

The evidence is not absolutely conclusive and yet it tends to single out the North Central section as the home of this practise and among the colleges and universities with an annual income of from $5,000 to $50,000.

Turning, now, to the second phase of the entire problem, the results obtained by the first somewhat rough method are reinforced by this more analytical method. Of the 347 institutions heard from, 121, or a little more than one third, excuse seniors from final examinations. Of these, 71 are institutions with an annual income of from $5,000 to $50,000. Still further, while but 39 per cent. of all the colleges and universities of the country are in the North Central section, 50 per cent. of all that excuse from examinations are located there, and 70 per cent. of these, or 43 out of 61, are institutions with from $5,000 to $50,000 income a year. These results are evident from Table XIV.

TABLE XIV

Distribution of the Institutions which Excuse Seniors from Final Examinations. Most of them Arranged according to Income Groups

	North Atlantic			South Atlantic			North Central			South Central			Western			Totals[10]			Totals
	Final Examinations Scheduled			Final Examinations Scheduled			Final Examinations Scheduled			Final Examinations Scheduled			Final Examinations Scheduled			Final Examinations Scheduled			
	For All Students at Same Time	For Seniors Earlier	Scattering[9]	For All Students at Same Time	For Seniors Earlier	Scattering	For All Students at Same Time	For Seniors Earlier	Scattering	For All Students at Same Time	For Seniors Earlier	Scattering	For All Students at Same Time	For Seniors Earlier	Scattering	For All Students at Same Time	For Seniors Earlier	Scattering	
Schools of technology............					1			1	1								2	1	3
Agricultural schools..............		2			1			1	1					1			5	1	6
State universities.................	1				1		2	1			2	1		1	2	3	5	3	11
State colleges.....................		2												1			3		3
Universities and colleges on private foundations with an annual income of: $100,000 or more...	4	3	1				2		1				2			8	3	2	13
$ 50,000 to $100,000		2					3	1	1					1	1	3	4	2	9
$ 25,000 to $ 50,000	2	1			3	1	3	6	4	2						7	10	5	22
$ 5,000 to $ 25,000	2			1	6	1	16	9	5	2	2	2	2		1	23	17	9	49
Less than $5,000....					1								1			1	1		2
Not listed.........							1	1	1							1	1	1	3
Totals..........	9	10	1	1	13	2	27	20	14	4	4	3	5	4	4	46	51	24	121
Totals..........	20			16			61			11			13			121			

[9] "Scattering" means that these postals did not indicate the attitude of the institution toward earlier examinations for seniors or at the same time as other students. They did indicate clearly exemption from examinations under certain conditions.

[10] This is a summary of the respective columns read across the table.

To make this study more complete one would need to show the tendency, that is, whether the custom of setting senior finals at the same time as the finals for other students is increasing, or *vice versa,* and whether excusing seniors from finals is becoming more or less prevalent. The questionnaire did not provide for this aspect of the matter. It was arranged so as to elicit the information sought speedily, and with the least amount of effort on the part of college and university registrars to whom it was sent. This much, however, may be said. Three eastern institutions, each with an income of at least $175,000 a year, have tried the method of earlier examinations for seniors and have abandoned it. This was learned from other sources. One of the cards, also, indicated that an eastern institution in the $100,000 income class, which is now following that practise, is seriously considering a change to the method of scheduling the final examinations for all students at the same time.

In regard to excusing from examinations, it may be said that the return postals from two institutions indicated that they are contemplating adopting this method, but both are in the class with an annual income of from $5,000 to $25,000, and in the North Central section. Fifteen postals, rather evenly distributed throughout the country, indicated by such expressions as "Never," "All stand examination," "Not excused under any condition," "All must take both mid-year and final examinations," a decided opposition to any such practise.

A few institutions indicated that the difficulty of grading seniors carefully, when their examinations come at the regular time, just before commencement, is met by putting senior subjects, so far as compatible with a rather wide range of electives, early in the examination period, which, it was shown, extends through one or two weeks.

In attempting to state briefly what this study has shown, I may not assume that there is any method that may be regarded as absolutely best. A practise which is generally favored may not be the best. It is the small group of institutions, or a single institution, which *may* by experiment discover a method superior to one long tried and approved. None the less, the practise of a decided majority of the better equipped institutions, judging from their annual income, is very significant. That majority is 48 to 25, as given on page 182. While not final, their insistence upon scheduling senior examinations at the same time as for other students, and their tendency not to excuse seniors from the second semester or spring term examinations, the majority against being about the same as in the other case, would seem to indicate what is best at present.

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WILLIAM MCMURTRIE[1]

WILLIAM MCMURTRIE was born on March 10, 1851, on a farm near Belvidere, N. J. He was an active, energetic lad at school and at Lafayette College, where he entered in the mining engineering course in 1868, graduating in 1871. While in college he was a member of the Franklin Literary Society and of the Zeta Psi fraternity. Among his classmates were the late John Meigs, proprietor of the famous Hill School of Pottstown; Dr. W. B. Owen, a well-known and influential member of the faculty of Lafayette College; D. B. King, of New York City, and H. P. Glover, of Mifflinburg, Pa.

In 1872 McMurtrie became assistant chemist in the U. S. Department of Agriculture at Washington, D. C., Dr. R. J. Brown being the chief chemist. Dr. Wiley says:

[1] Several biographical notices of Dr. McMurtrie have already appeared—one by Dr. C. P. McKenna in *The Percolator,* issued regularly by the Chemists' Club of New York City (June 20, 1913), a more extended notice by Dr. H. W. Wiley in the *Journal of Industrial and Engineering Chemistry* (July, 1913, p. 616). The last named contains a bibliography by Douglas C. McMurtrie. I have drawn upon both these sources. The dates are from Dr. Stonecipher's "Bibliographical Catalogue of Lafayette College" and from "Who's Who in America."

On entering the laboratory, I found one assistant at work; a young man with jet-black hair and pleasing appearance, seated on a high stool before a desk, attending to some of the details of an analysis. . . . This was my first meeting with Dr. McMurtrie and the beginning of a friendship which continued unabated until the time of his death. . . . Within the next two years from the time of which I speak, Dr. Brown retired from the position of chief chemist of the Department of Agriculture and Dr. McMurtrie took his place. He was at that time, though only twenty-one years of age, well trained in chemistry, as training was regarded in those days. . . . When he entered Lafayette College there was no special course of chemistry, so he took mining engineering because in that he could have the best chemical training which the college afforded.

The story of how he was selected for the succession to Dr. Brown reveals one of the characteristics of his whole life, namely, unselfishness. Judge Watts was at the time Commissioner of Agriculture. When Dr. Brown retired a number of applications for this position came in. Commissioner Watts called young McMurtrie into his office and asked him what he thought of the qualifications of the applicants. He said he did not think any one of them was properly qualified for the position. Commissioner Watts then asked him if he thought he could do the work and would like the position. He replied that the idea of succeeding Dr. Brown had never entered his mind, but he thought he could do better than any of the men who were being considered.

In 1876 he married Helen M. Douglas, who with his son, Douglas C., survives him.

In 1878 he became agent of the U. S. Department of Agriculture and superintendent of the agricultural section at the Exposition Universelle at Paris. His account of the work is contained in the first volume of the Report of the U. S. Commissioners, page 113. An interesting confirmation of Dr. McMurtrie's modesty is to be inferred from a certain letter contained in the volume just cited from Mr. McCormick, Commissioner General, to Secretary Evarts, in which he states that "there is an eager movement upon the part of certain Americans here to secure decorations from the French government." Dr. McMurtrie's name does not appear in this list, but in 1883 he was made a Chevallier du Merite Agricola "because of service rendered in agriculture."

From 1879–1882 he was special agent of the Department of Agriculture in agricultural technology and wrote several valuable reports, only a part of which were published. Among these were reports on "The Mineral Nutrition of the Vine," "A Report on the Culture of Sumac in Sicily," on the "Culture of the Sugar Beet," on the "Examination of Raw Silks," and "A Report upon an Examination of Wools and other Animal Fibers." His reports upon "Sugar Beet Culture" and upon "Wool" are considered especially valuable. The subject last named he returned to, publishing two further reports in 1887 and 1901.

In 1882 McMurtrie became professor of chemistry at the University of Illinois at Champaign, in 1884 chemist of the Illinois State Board of Agriculture and in 1886 chemist of the Agricultural Experiment Station.

In 1888 he came to New York as chemist of the New York Tartar Company. He took charge of their factory in Brooklyn and revolutionized the methods of manufacture, trying one method after another until he finally succeeded in making perfectly pure cream of tartar and tartaric acid on a manufacturing scale at a reasonable cost. In further prosecuting the work of the Royal Baking Powder Company he organized a complete factory for making tin containers for their product. This was highly successful and is still considered a model factory for this purpose.

Dr. McMurtrie was very much interested in the reorganization of the American Chemical Society, which was undertaken in 1893 when Dr. Wiley became president. I was then editing the *Journal of Analytical and Applied Chemistry* and Dr. Wiley came to me with the suggestion that I had better either give up my own journal and run the *Journal of the American Chemical Society* as editor or edit both journals. I told him at once that I would decline the second proposition but would hold the first under advisement, and I finally consented. When the arrangement was concluded it was June. We had two papers and were six numbers in arrears. By the end

of the year twelve numbers had been issued and the membership had begun to increase. At that time, if my memory is correct, there were less than 500 members, many of whom were in arrears for dues. During my editorship, which continued for nine years, Dr. McMurtrie was a very active member of the council and in 1900 became president. He was ready to sacrifice his time and means in the service of the society and expected the rest of us to do as much. The salary list during these years was ridiculously small, yet a tremendous amount of work was accomplished.

Dr. McMurtrie was a man of fine presence, agreeable manners and great kindness of heart. He died May 24, 1913.

EDWARD HART

PUBLICATIONS OF THE DEPARTMENT OF AGRICULTURE

THE Secretary of Agriculture has announced new plans of publication work for that department. There has been an independent series of bulletins and circulars in each of the thirteen publishing bureaus, divisions and offices of the department. These have been discontinued and will be superseded by the *Journal of Research* for printing scientific and technical matter, and by a departmental series of bulletins, written in popular language for selected and general distribution. By this plan the confusion that has resulted from the multiplicity of series of publications will be avoided, and the saving of a considerable sum will annually be effected.

Under the new plan the department will discontinue the general distribution of matter so scientific or technical as to be of little or no use to the lay reader. It will supply technical information only to those directly interested and capable of using scientific analyses, and of understanding the results of research work couched in scientific terms. A larger amount of information in popular form which the average reader can immediately apply to his own direct advantage, and thereby increase the agricultural productiveness and the health of the nation, will hereafter be distributed.

The highly scientific matter heretofore published indiscriminately in bulletins and circulars will hereafter be published only in the newly established *Journal of Research,* which will be issued about once a month. It will be royal octavo, of the scientific magazine type, from 75 to 100 pages, 12 numbers to constitute a volume. Such of the matter in the *Journal* as seems to merit additional circulation may be issued in the form of reprints or separates. The *Journal,* for the present at least, will be limited to the publication of the results of research made by the various bureaus, divisions and offices, but it may be extended to include the scientific research work of the state agricultural experiment stations, in which event two editors representing these stations will be added to the editorial committee. Extensive scientific articles, embodying a complete report of research investigations, will be considered as monographs, and may be published as supplements to the *Journal.*

Permission will be given to specialists to publish technical reports or even monographs in journals of scientific societies or technical magazines specializing in highly restricted fields of scientific endeavor.

The *Journal* will be distributed free to agricultural colleges, technical schools, experiment stations, libraries of large universities and certain government depositories and institutions making suitable exchanges; also to a restricted list of scientific men. Copies of the *Journal* will be sold to miscellaneous applicants by the superintendent of documents, Government Printing Office, and possibly an annual subscription price will be affixed, as is done with the *Experiment Station Record.*

The *Monthly Crop Reporter* will no longer be published. The crop statistics will be collected as heretofore, and telegraphic and news summaries of these statistics will continue to be issued to the press. The printed *Crop Reporter* was discontinued because it did not bring the information into the hands of the recipients until from 10 to 17 days after the really important news had been circulated by telegraph and printed in the daily press throughout the United States and Europe, the statistical information, therefore, reaching the

actual crop correspondent and through him the local producer too late to be of practical service.

As a partial substitute for the printed *Crop Reporter,* a *Weekly News Letter* to crop correspondents will be issued in typewritten facsimile form. This can be prepared and put into the mails sooner than was possible with the printed *Reporter.* It is believed that the weekly news will be far more timely than notices issued heretofore only once a month. Its circulation will be limited to official crop correspondents. The *News Letter* will contain summaries of more important discoveries and recommendations of the various bureaus, divisions and offices.

The *Experiment Station Record,* the *Weather Review* and *North American Fauna* will continue to be issued with certain modifications. The *Yearbook* will be restricted to articles of the magazine type, which, it is believed, will add greatly to the popularity and value of the volume, of which 500,000 copies are printed and distributed annually.

In the department series of bulletins all the publications of the various bureaus, divisions and offices will be printed. These bulletins may be any size from 4 to 60 pages, and will be semi-technical or scientific, or popular in character. They will capitalize for popular use the discoveries of laboratories and scientific specialists.

The series of farmers' bulletins will be continued. The object of these bulletins is to tell the people how to do important things. The bulletins will contain practical, concise and specific and constructional statements with regard to matters relating to farming, stock raising, fruit growing, etc. Under the new plan the bulletins will be reduced in size to from 16 to 20 pages, and will deal particularly with conditions in restricted sections, rather than attempt, as heretofore, to cover the entire country. Much of the information calling for immediate circulation will be issued hereafter in the form of statements to the press instead of being held back as heretofore for weeks until a bulletin could be printed and issued. The publication of bulletins dealing with foreign crop statistics will be discontinued. Material of this character when deemed important will be furnished to the press for the information of the public.

Consideration is being given to the discontinuance of certain annual reports of bureaus now required by law to be printed, with the belief that much of the matter therein contained is unnecessary, while certain portions could be more advantageously and more promptly printed as bulletins of the department. All executive reports of chiefs are to be reduced with the object of confining them to strictly business reports.

The new plan of publication work has been designed primarily to improve the character of the department's publications, and secondarily to prevent waste in distribution, and through the economies effected, a greater output of information will become possible with the available appropriation. Certain changes will be made in the existing form of the publications, designed with a view to improving their appearance, reducing their size and adapting them to wider distribution.

SCIENTIFIC NOTES AND NEWS

Charles F. Marvin, professor of meteorology in the U. S. Weather Bureau since 1891, chief of the instrument division, has been appointed chief of the Weather Bureau, to succeed Mr. Willis L. Moore.

The council of the Royal College of Surgeons, London, has elected the following honorary fellows: Dr. Harvey Cushing, professor of clinical surgery at Harvard University; Dr. W. J. Mayo, surgeon at St. Mary's Hospital, Rochester, Minn., and Dr. George Crile, professor of surgery at Western Reserve University, Cleveland.

The trustees of the Beit memorial fellowships, on the advice of the advisory board, have decided to assist further research as to the nature of the virus of sand-fly fever, a disease which is the cause of much sickness in the ships of the Mediterranean Squadron and among the troops stationed at Malta and in certain parts of India and elsewhere. The

army council has approved of Captain P. J. Marett, R.A.M.C., who has already published papers on the subject, undertaking this research in addition to his military duties at Malta. Captain Marett will have the title of Beit Memorial Research Fellow.

MME. CURIE has been organizing a radium laboratory in Warsaw, but will return to her laboratory at the Sorbonne in the autumn.

DRS. WILLIAM H. WELCH and Lewellys F. Barker, of the Johns Hopkins University, have sailed for Europe.

DR. JOHN A. FERRELL has been appointed general manager of the hookworm work of the Rockefeller Foundation, with headquarters in Washington.

THE steamship *Eric*, taking the McMillan Crocker Land expedition into the arctic regions, reached Battle Harbor on August 3. She takes on board supplies and outfit landed from the disabled *Diana*, and expected to leave for the north on August 4.

MR. VILHJALMAR STEFANSSON cables to the New York *Times* that the *Karluk* and the *Mary Sachs* sailed from Port Clarence, Alaska, about midnight on July 23. "The *Alaska* will follow in four days and may overtake us near Herschell Island about the middle of August." There are fifteen scientific men and twenty-two others on the three vessels. The outfit is complete for two years, and may be made to last longer. No fear need be felt for the *Karluk* if she is not heard from for two years. The *Alaska* and the *Mary Sachs* should be heard from twice yearly, in October by whalers through Bering Straits, and in January by mounted police through Dawson.

DR. K. TH. PREUSS, of the Berlin Anthropological Museum, will undertake in September explorations in Colombia.

DR. R. S. BASSLER, of the National Museum, Washington, spent two days recently at the Oberlin Geologic Survey Camp at Rich Creek, Va., reviewing with them parts of the early and middle Paleozoic sections exposed in the vicinity. In the evening of July 25 he gave a lecture before the camp students on "Some Recent Developments in the Theory of Appalachian Stratigraphy."

IT was stated in a recent issue of SCIENCE that the Hon. James Wilson, lately Secretary of Agriculture, has been given the degree of doctor of science from the University of Edinburgh. The degree given was doctor of laws, the Scottish universities not conferring the degrees of doctors of science, letters or philosophy *causa honoris*, but only in course.

PROFESSOR M. A. ROSANOFF, of Clark University, has been invited to speak before the *Versammlung deutscher Naturforscher* at the University of Vienna, on the mechanism of esterification and esterhydrolysis. The conference will last from September 21 to 26. Dr. Rosanoff expects to sail on August 26 and to be back early in October. In course of the past academic year Dr. Rosanoff lectured on parts of the same subject before the New York and Northeastern Sections of the American Chemical Society, the research staff of the General Electric Company at Schenectady, the industrial research department of the University of Pittsburgh and the chemical department of Wesleyan University.

THE city authorities of Berlin propose to appropriate $250,000 for the erection of the Rudolf Virchow House for the Berlin Medical Society.

PROFESSOR JOHN MILNE, distinguished for his work in seismology, died at his home in the Isle of Wight, on July 31, aged sixty-three years.

PROFESSOR CHARLES SIMEON DENNISON, since 1885 professor of descriptive geometry and drawing in the University of Michigan, has died at the age of fifty-four years.

A MISCELLANY in honor of the sixtieth birthday of Dr. William Ridgeway, professor of archeology in Cambridge University, is in course of preparation and will be issued in October. The volume will contain some congratulatory verses by A. D. Godley, public orator in the University of Oxford, Greek verses by Professor John Harrower, a photogravure portrait of Professor Ridgeway, and a series of articles on classics and ancient arche-

ology, medieval literature and history and anthropology and comparative religion. In the latter subjects the contributions are as follows:

E. Thurston, "The Number Seven in Hindoo Mythology."

T. A. Joyce, "The Weeping God."

S. A. Cook, "The Evolution and Survival of Primitive Thought."

J. G. Frazer, "The Serpent and the Tree of Life."

W. Boyd Dawkins, "The Settlement of Britain in the Prehistoric Age."

W. Wright, "The Mandible from the Morphological and Anthropological Point of View."

C. G. Seligmann, "Ancient Egyptian Beliefs in Modern Egypt."

W. L. H. Duckworth, "Craniological Notes."

W. H. R. Rivers, "The Contact of Peoples."

J. Rendell Harris, "The Dioscuri in Byzantium and its Neighborhood."

C. S. Myers, "Primitive Music."

Henry Balfour, "Some Peculiar Fishing Appliances and their Geographical Distribution."

A. C. Haddon, "The Outrigger Canoes of Torres Straits and North Queensland."

J. H. Moulton, "Notes in Iranian Ethnography."

The British Board of Agriculture and Fisheries has awarded research scholarships in agricultural science of the annual value of £150, tenable for three years, to the following candidates, viz.: E. W. Barton (Wales), economics of agriculture; W. Brown (Edinburgh), plant pathology; Miss E. C. V. Cornish (Bristol), dairying; F. L. Engledow (London), genetics; E. J. Holmyard (Cambridge), plant nutrition and soil problems; R. C. Knight (London and Bristol), plant physiology; F. J. Meggitt (Birmingham), agricultural zoology; H. Raistrick (Leeds), animal nutrition; G. O. Sherrard (Dublin), genetics; T. Trought (Cambridge), genetics; G. Williams (Wales), animal nutrition; S. P. Wiltshire (Bristol), plant pathology; Miss T. Redman (London), dairying. The scholarships have been established in connection with the scheme for the promotion of scientific research in agriculture, for the purposes of which the treasury has sanctioned a grant to the board from the development fund; they are designed to provide for the training of promising students under suitable supervision with a view to enable them to contribute to the development of agricultural science.

The new Natural History Department of the Birmingham Museum and Art Gallery was formally opened on July 17. The museum, as we learn from *Nature,* comprises four galleries, one of which is not yet opened, having been reserved for the Beale Memorial Collection, which is to consist of nesting groups of British birds. The collections, which have been arranged by Mr. W. H. Edwards, contain representatives of most sections of natural history, though birds, shells and insects predominate at the present time.

The late Miss Henriette Hertz, who died at Rome on April 9, has, according to the London *Times,* left the following benefactions to the British Academy: £2,000 for an annual lecture or investigation or paper on a philosophical problem, or some problem in the philosophy of western or eastern civilization in ancient and modern times; £2,000 for an annual lecture or investigation or paper on some problem or aspect of the relation of art (in any of its manifestations) to human culture, art to include poetry and music as well as sculpture, painting; £1,000 for an annual public lecture on some master mind, considered individually with reference to his life and work, specially in order to appraise the essential elements of his genius, the subjects to be chosen from the great philosophers, artists, poets, musicians; £1,000, the income of which is to be used to promote the publication of some philosophical work to reward some meritorious publication in the department of philosophy. The testatrix has also left the sum of £1,500 to Girton College, the income to be used for the endowment of archeological research. Her main benefaction is devoted to the foundation of the "Bibliotheca Hertziana" in the Palazza Zuccari, for the promotion of Renaissance studies.

The inroads of the chestnut bark disease, or chestnut blight, on the chestnut trees of New England and the Middle Atlantic States

is resulting in the death of a great deal of chestnut timber. Officials of the U. S. Department of Agriculture recommend, to prevent the spread of the disease, that shipments of chestnut timber should include only material from which the bark has been removed and from which the diseased spots have been cut out. In the region affected there is a good market for all chestnut products except cordwood. The demand for poles and ties absorbs all that are offered, and lumber finds ready sale in local markets. Cordwood, however, is often a drug except within shipping distance of tanning extract plants, brass foundries, lime kilns, brick yards and charcoal plants. The question has arisen as to whether the disease-killed timber is less valuable than that from green trees. Strength tests made by the Forest Service indicate that sound wood from chestnut killed by the bark disease is as strong as that from green timber. The bark disease kills the tree by girdling the trunk, and does not cause unsound or decayed wood, which is the result of attack by fungi or insects. Until two years after the death of the tree the wood generally remains sound, though at the end of that time insects have commenced working in the sapwood. Three years after death the sapwood is honeycombed with insect burrows; in four years it has decayed, and begins to dry and peel off in the fifth year. After this the heartwood checks badly. To avoid loss, therefore, all timber should be used within two years after being killed. At a recent meeting in Trenton, N. J., foresters were present from most of the states in which the chestnut bark disease is prevalent. Connecticut, New Jersey, New York, Pennsylvania, Virginia, West Virginia, North Carolina, and the Forest Service and the Bureau of Plant Industry were represented. Representatives of the states approved the investigations undertaken by the Forest Service, and recommended that the individual states give particular attention to the development of local markets for stands of blight-killed chestnut. Owners of such timber should apply to the state foresters or to the Forest Service for further information upon the uses and markets for chestnut.

WE learn from *Nature* that a large number of distinguished physiologists, biologists and medical men have signed a letter addressed to the home secretary directing attention to the scientific aspects of the administration of the Mental Deficiency Bill. The signatories desire to secure the continuous prosecution of research into the conditions on which mental deficiency depends, and into the means by which it might be remedied or prevented. They point out that it may be said, in a general way, that the conditions in question must be due either to defective formation and development of the active structures of some portion or portions of the brain, or to defective formation or supply of the fluids by which these structures are surrounded, and by which they are stimulated to activity. For example, one common form of idiocy is consequent upon the absence from the blood of the secretion which should be furnished by the thyroid gland, and may be remedied by the administration of thyroid extract derived from lower animals. The Mental Deficiency Bill will probably bring together many of its subjects into institutions controlled by the state, and supported by the public. It is therefore urged that the facilities for scientific study which such institutions would afford should be fully utilized for the general benefit of the community, and that the duty of so utilizing them should be committed to men of science, fully conversant with all that is already known in relation to the subject, and able to point out the directions in which further inquiry should be pursued. It is suggested that the objects in view could scarcely be obtained except by an adequate representation of biological science upon any commission to which the administration of the law may be entrusted.

AN agricultural colony in Palestine has applied to the U. S. Forest Service for help in planting trees to bind the drifting sands of the Mediterranean. The colony is near Jaffa, or Yafa, the ancient Joppa of the Bible, and there is being developed in connection with it a seaside resort, with hotel, villas, bath houses and gardens. The experts of the service point out that the reclamation of sand dunes is not a serious problem in the eastern

United States because the prevailing winds are from the land and the sand is blown into the sea. On the west coast the situation is more serious. The most notable example of reclaimed sand areas there is furnished by Golden Gate Park, San Francisco, where grasses, acacias and, later, trees and shrubs have converted sand wastes into pleasure grounds of great beauty. The attention of the Palestine colony is called to the wonderful reclamation of the Iandes, France, where a wealth-producing forest of maritime pine, the source of the French turpentine, has been grown to take the place of shifting dunes. The American foresters also give the address of the French seedsman who furnished this government with the maritime pine seed which has been used in planting experiments on the Florida national forest, near the Gulf coast.

The Secretary of Agriculture has signed an agreement with the state of North Carolina for a cooperative study of forest conditions in the eastern piedmont region. The work will be carried on by the forest service and by the state geological and economic survey with one half of the cost paid by each. The study will determine the distribution and proportion of forest lands, and the relative value of lands for timber and for agriculture. It will take into account the present status of lumbering, the causes and effects of forest fires, and will recommend a system of fire protection and of forest planting. The study arranged supplements two already completed in the more mountainous regions of the state. The first, a study of forest conditions in the Appalachians, has been published as a state report. A study of the forests of the western piedmont region was completed recently and the results are being prepared for publication. When the study of the eastern piedmont region is finished it is planned to proceed to a similar study of the coastal plain region, so that eventually the entire state will be covered by a forest survey.

UNIVERSITY AND EDUCATIONAL NEWS

Governor Tener, of Pennsylvania, has, after revision, approved the following state appropriations made at the last session of the legislature: The Pennsylvania State College, $1,240,000, in addition to income from Land Grant Fund and congressional appropriation to Land Grant Colleges; University of Pennsylvania, $820,000; University of Pittsburgh, $400,000 and Temple University, $100,000, making the total state appropriation for higher education $2,560,000.

Franklin College, Indiana, has secured pledges aggregating two hundred and fifty thousand dollars for additional endowment. Three sixteenths of this amount is from the General Education Board.

Middlebury College has received $30,000 as the residuary legatee of the late Henry M. Barnum.

Sir William Ramsay, emeritus professor in University College, London, has given the college £500 for books and journals for the chemical library.

The medical department of Tulane University will hereafter be known as the Tulane College of Medicine and will be divided into four schools, each with a separate dean and staff, namely: the School of Medicine and Pharmacy, dean, Dr. Isadore Dyer; the Post-Graduate School, dean, Dr. Charles Chassaignac; the School of Hygiene and Tropical Medicine, dean, Dr. Creighton Wellman, and Dentistry, dean, Dr. Andrew Friedrichs. The following elections and changes have been made in the Post-Graduate School: Dr. Henry Dickson Bruns, transferred from the emeritus to the active list, as professor of diseases of the eye; Dean Creighton Wellman, elected professor of tropical diseases and preventive medicine; Dr. J. T. Halsey, elected professor of clinical therapeutics; Dr. C. C. Bass, elected professor of clinical microscopy; Dr. W. W. Butterworth, elected professor of diseases of children, and Dr. George S. Bel, elected professor of internal medicine.

Professor W. A. Stocking, Jr., of the dairy department of the New York State Agricultural College at Cornell University, has been appointed to succeed Dr. L. H. Bailey as acting director of the Agricultural College.

Mrs. Ella Flagg Young has withdrawn her resignation as superintendent of the Chicago

public schools, the newly organized school board having declined to accept it, by vote of fourteen to one.

Dr. Arthur D. Hirschfelder, of Johns Hopkins Medical School, has accepted the appointment of professor of pharmacy and director of the pharmaceutical department of the University of Minnesota.

Dr. J. M. Slemons, associate professor of obstetrics at Johns Hopkins Medical School, has been appointed head of the department of obstetrics and gynecology and director of the woman's clinic in the University of California.

Mr. Harold S. Osler has been elected assistant professor of agronomy, in charge of the crops section at the University of Maine.

Mr. J. B. Demaree, recently of the Ohio Agricultural Experiment Station, and for the last six months engaged in the study of plant rusts at the Indiana Experiment Station, has accepted a position in the State College of Pennsylvania as instructor in botany.

Professor Kruse has accepted the call as director of the Hygienic Institute at Leipzig as successor of Professor Hofmann.

DISCUSSION AND CORRESPONDENCE

THREE ICE STORMS

During the last two weeks in February, 1913, two ice storms which were of rather unusual meteorological interest, were observed at Blue Hill Observatory (10 miles south of Boston, Mass.). An "ice storm" (glatteis, verglas) occurs when raindrops falling on trees and other objects, cover them with ice. In both cases the ice storms began at the base station (400 feet below the summit and one half mile northwest) nearly three hours earlier than at the summit. The first ice storm occurred during the night of February 16–17. Throughout the sixteenth at the summit of Blue Hill, the wind was southerly, with the temperature in the forties (F.). In the middle of the afternoon, a low fog appeared over Boston. By sunset, this fog filled the entire Boston basin and was beginning to send long fingers southward through the notches in the Blue Hill Range and up the low Neponset Valley. Not till three hours later did the fog overtop Great Blue Hill with its accompanying northeast wind and freezing temperature. The warm south wind, whose lower boundary had now risen above the hill, continued above the lower wedge of cold air and with its rain supplied the material for the ice storm below.

The second storm began in the morning, February 27, and continued for twenty-four hours, the ice attaining a thickness of one inch. The night before, at a temperature of 26° a fine thick snow had set in with a brisk southeast wind. In the early morning, the temperature passed 32°, the snow changing to rain. At 5:20 A.M. the first influence of a cold current of air from the north was recorded on the thermograph at the base station (temperature fell rapidly from 35° to 31°). Not till 8:15 A.M. did the wind on the summit swing to the north, lowering the temperature to that of the base station. The warmer air current continued above, unabated, for at 9 P.M. the light rain had become heavy (rain temperature 32.3°) and the cold, northeast wind (27°–31°) had increased to brisk. On the following morning in the warm sunshine and rapidly rising temperature, the ice melted off the trees so rapidly that for half an hour the sound of falling ice resembled that of a heavy hailstorm.

Another ice storm deserving mention here was that of February 21–22. The weather map of February 21 showed an ice storm in progress over a strip of country 100–200 miles wide, extending from northern Texas to southern Michigan. The next morning, this ice-storm belt was shown as a strip about forty miles wide from northern Vermont to southern Maine. The geographical distribution of the different forms taken by the heavy precipitation throughout New Hampshire was particularly interesting as viewed from a train window two days later. At Jackson, N. H., the precipitation on February 22 had been about seven inches of snow and one inch of ice pellets. Southward, this snow-covering decreased rapidly into a thin, compact blanket of ice pellets and frozen rain, ice appearing on

the trees within 20 miles south of Jackson. At 40 miles south of Jackson, the smaller trees were so loaded with ice that they were bent to the ground and many branches had been broken off. Ten miles farther south, at Rochester, N. H., there was no more ice on the trees nor snow or ice on the ground. This great difference in ice and snow covering was the result of a difference in temperature of not more than 5° (31° Jackson, 33°–40° Blue Hill).

In each of these three cases the daily weather maps showed an area of high pressure ("high") directly north of a low pressure area ("low"), both moving slowly eastward, each more or less in the way of the other because of the prevailing tendency of a "high" to move east-southeast and of a "low" to move east-northeast in these parts of the United States. These cyclones ("lows") were thus amply supplied with cold air in their northern quarters. The ice storms occurred in the region where the normal warm southerly winds on the east side of the cyclones overlapped the cold north and northeast winds on the northern side.

Charles F. Brooks
Blue Hill Meteorological Observatory

A PHLEBOTOMUS THE PRACTICALLY CERTAIN CARRIER OF VERRUGA

Experiments on laboratory animals with bloodsucking arthropods, looking to the solution of the problem of verruga transmission, have been under way at Chosica, Peru, in charge of the writer, since May 15, 1913. A study of the bloodsuckers occurring in the verruga zones has been going on for a longer time. At first the writer strongly inclined to the theory of tick or other acarid transmission, but the trend of the investigation has been to make such transmission seem very improbable of late. No argasid ticks have been found to occur commonly on mammals in the verruga zones, and ixodid ticks will hardly explain the night infection. The experiments in feeding, biting and subcutaneous injection of animals with the bloodsucking Gamasid mites of the vizcacha, which seemed at first most promising, have so far entirely failed of result. A resurvey of the situation had therefore become necessary in order to start out on new lines.

Culicids, *Simulium*, Tabanids, *Stomoxys*, fleas, lice and bugs are all precluded either by their extended occurrence, by their dependence on man, or by their day-biting proclivities. The question of punkies and like small gnats remains. The writer's attention has recently been drawn to the possibilities of *Phlebotomus*, chiefly through the investigations recently published by Marett on the genus in the Maltese Islands. His results are most impressive and suggestive in this regard. The habits of the early stages and of the flies, as described by Marett, fit so well into the conditions obtaining in the verruga zones that the conclusion was irresistible that a *Phlebotomus* must be the carrier of verruga. Hitherto there has been no record of the occurrence of *Phlebotomus* in Peru, or anywhere in the Pacific coast region of South America.

Ceratopogon and other genera of Chironomidæ with mouth-parts more or less adapted for bloodsucking occur at night both in and out of the verruga zones. They were therefore contraindicated. Night collecting at Chosica, just below the limits of the verruga zone, has never disclosed *Phlebotomus*, and as these gnats are never seen under ordinary circumstances in the daytime the writer determined to investigate the verruga zone by night in order to demonstate if possible the existence of *Phlebotomus* therein. Accordingly he passed the night of June 25, 1913, at San Bartolomé in the verruga zone of the Rimac valley. The result was that, besides *Ceratopogon* and other Chironomids, several specimens of *Phlebotomus* were actually found. The natives call all nocturnal gnats *titira*, considering that most of them bite, but certain of the more intelligent distinguish the true *titira* as the *Phlebotomus* sp., stating that it has white wings.

The true explanation of the oft-repeated facts that verruga is confined to deep and narrow canyons, with much vegetation, heat and little or no ventilation, evidently lies here. The flies of *Phlebotomus* avoid wind, sun and full daylight. They appear only after sunset,

and only then in the absence of wind. They enter dwellings if not too brightly lighted, but are not natural frequenters of human habitations. They breed in caves, rock interstices, stone embankments, walls, even in excavated rock and earth materials. The verruga canyons contain ideal conditions for such breeding. They hide by day in similar places or in shelter of rank vegetation. Deep canyons, free from wind and dimly lighted, are especially adapted to them. Thick vegetation protects them from what wind there is by day or night. This explains the very peculiar restricted distribution of verruga both local and altitudinal. The flies suck the blood of almost any warm-blooded animal, and even that of lizards in at least one known case. Thus they are quite independent of man, and this accords with the verruga reservoir being located in the native fauna. The habits of *Phlebotomus* correspond throughout so minutely with the conditions of verruga and the verruga zones that the writer wishes to announce his entire confidence in the belief that the transmission experiments, now about to be initiated with these gnats on laboratory animals, will demonstrate their agency in the transmission of the disease.

Charles H. T. Townsend

Chosica,
June 29, 1913

SCIENTIFIC BOOKS

Examination of Waters and Water Supplies. By John C. Thresh. Second edition. Philadelphia, P. Blakiston's Son & Co. 1913. 644 pages; 36 plates; 16 illustrations in the text. Price $5.

This is a new edition of a book that is well known to American waterworks engineers. The author is one of the foremost water analysts in England and the book shows evidences that it is written by one who speaks with authority. It is needless to describe the book in detail.

Part I. relates to the examination of the sources from which water is derived. Part II. treats of the various methods of examining water and the interpretation of the results of such examinations. Part III. describes in more detail the analytical processes and methods of examination.

Most American readers will be particularly interested in the first three chapters that relate chiefly to ground water. The author describes numerous personal experiences in the detection of underground pollution, and an excellent description is given of the use of fluorescein, and other substances which may be detected either by sight or by smell, in tracing the course of water through the ground. From his experience he states that water which enters a dug well at a depth of six to twelve feet, depending upon the porosity of the soil, is usually efficiently filtered and purified. Water entering at a less depth is nearly always liable to be imperfectly purified and unsatisfactory in quality. The nearer the ground surface at which water can enter the greater the danger of pollution.

One statement of the author will strike most readers with surprise, namely, "Every known fact with reference to typhoid fever epidemics indicates that the typhoid bacillus alone is not the cause of disease, and it has long been suspected that some other organism either by itself or in conjunction with the typhoid bacillus was the cause." He then quotes from an article in the *Lancet* and describes a new anaerobic bacillus which has been found only in the feces of typhoid fever patients and which is agglutinated by their serum. It is a spore-bearing organism and is said to be capable of retaining its vitality for a very long period.

An interesting example of the growth of organisms in water mains is mentioned. A thirty-six-inch main at Hampton-on-Thames was recently taken up and found to contain fresh-water mollusks to such an extent that its bore was reduced to nine inches. It was estimated that ninety tons of mussels were removed from a quarter of a mile of this main.

Reference is made to the ill effect of the continued use of soft waters on the human system, and a method of artificially hardening water by the addition of calcium chloride and sodium bicarbonate is described.

Dr. Thresh makes occasional reference to permutit for purposes of water softening and recommends its use where the quantity of water to be treated is not large. This substance is coming into vogue both in this country and in Europe. By its use carbonates and sulphates of soda are substituted for the corresponding salts of lime and magnesia.

In discussing lead poisoning it is said that "no water acts upon lead unless both carbon dioxide and oxygen are present. It seems probable that when carbonic acid is in a certain excess a solvent action is exerted, whereas when oxygen is in excess the action is erosive."

The author's treatment of the biology of water is somewhat less detailed than that of its chemistry, but some experiences are related by him which are of interest, as, for example, the effect which the process of water softening has in reducing the number of bacteria in water. The bacteriological discussion is materially strengthened by quotations from Dr. Houston's answers to two specific questions, namely, "What bacteriological proof would you consider conclusive as to the pollution of a water with sewage, or manurial matter, and what bacteriological proof would you consider conclusive that a water is free from such pollution or so free that it is safe for drinking purposes"? The answers to these questions can not be stated in a few words, but Dr. Houston apparently regards a water which never contains *B. coli* in 100 c.c. as safe for drinking; a water which contains *B. coli* in 100 c.c. in less than half the number of samples examined as probably reasonably safe; but a water which contains *B. coli* in 100 c.c. in a majority of samples is one to be viewed with some degree of disfavor. Waters containing *B. coli* in smaller amounts in a majority of samples can not perhaps with absolute certainty be classed as sewage polluted, but the presumptive evidence increases to a more than proportional extent as a 10, a 1 and a 0.1 c.c. standard is infringed. Dr. Houston's standards appear to be somewhat more strict than those commonly discussed in this country.

The section of the book which describes in detail the mineral constituents of the alkaline waters of the London basin is interesting to analysts. More than four hundred of these analyses are given in detail.

In regard to the methods of analysis little need be said. They do not differ materially from those described in the first edition of the book and represent the ordinary English practise.

George C. Whipple

Harvard University

Herbals, their Origin and Evolution. A chapter in the History of Botany. 1470–1670. By Agnes Arber. Cambridge, the University Press. 1912. Octavo. Pp. xviii + 253.

The reason for writing this book is well stated by the author in her preface as follows: "My excuse must be that many of the best herbals, especially the earlier ones, are not easily accessible, and after experiencing keen delight from them myself, I have felt that some account of these works, in connection with reproductions of typical illustrations, might be of interest to others." A little later she says more specifically: "The main object of the present book is to trace in outline the evolution of the *printed herbal* in Europe between the years 1470 and 1670; primarily from a botanical, and secondarily from an artistic, standpoint."

In carrying out this object the author divides her book into nine chapters, whose headings will give a fair idea of its scope, as follows: I. The Early History of Botany (9 pages); II. The Earliest Printed Herbals (23 pages); III. The Early History of Herbals in England (12 pages); IV. The Botanical Renaissance of the Sixteenth and Seventeenth Centuries (72 pages); V. The Evolution of the Art of Plant Description (15 pages); VI. The Evolution of Plant Classification (20 pages); VII. The Evolution of the Art of Botanical Illustration (50 pages); VIII. The Doctrine of Signatures, and Astrological Botany (17 pages); IX. Conclusions (6 pages). In addition there are two appendices, I., containing a Chronological List of the Principal

Herbals and Related Botanical Works Published between 1470 and 1670 (14 pages), and II., containing A List in Alphabetical Order of the Principal Critical and Historical Works dealing with the Subjects Discussed in this Book (6 pages). A good index completes the volume.

In the first chapter we find some suggestive sentences. "From the very beginning of its existence, the study of plants has been approached from two widely separated standpoints—the philosophical and the utilitarian. Regarded from the first point of view, botany stands on its own merits as an integral branch of natural philosophy, whereas from the second it is merely a by-product of medicine or agriculture. This distinction, however, is a somewhat arbitrary one; the more philosophical botanists have not disdained at times to consider the uses of herbs, and those who entered upon the subject with a purely medical intention have often become students of plant life for its own sake. At different periods in the evolution of the science one or other aspect has predominated, but from classical times onwards it is possible to trace the development of these two distinct lines of inquiry, which have sometimes converged, but more often pursued parallel and unconnected paths." From which it will be seen that the advocates of "practical" botany to-day are but the modern representatives of the utilitarian schoolmen of the past.

The earliest printed book containing "strictly botanical information," we are told, was a work by Bartholomew, "Liber de Proprietatibus Rerum," which appeared about 1470. Quotations of text or figures are given from the "Ortus Sanitatus" (1491), "The Grete Herball" (1526), Brunfels's "Herbarum vivae Eicones" (1530), Turner's several works (1538–1551), Gerard's "Herball" (1597), the works of Bauhin, Dodoens, Lobelius and many others. The illustrations are most interesting, as showing the development of scientific drawing. Some of the earlier representations of plants were little more than *suggestions* of their appearance (and often of habitat, also), while others, though crude, actually gave a good idea of the characteristic appearance of the plants. The early artists appear to have conventionalized many of their drawings after fashions of their own, then perhaps familiar to the reader, but now not understood.

The chapter on the Doctrine of Signatures (VIII.) will repay reading, especially by the younger school of botanists of to-day. Will the time ever come when the botanists of some later century will look back to *our* beliefs with feeling similar to those we have when we read about the doctrine of signatures?

CHARLES E. BESSEY

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Vergleichende Physiologie Wirbelloser Tiere. Von Professor Dr. H. JORDAN. Erster Band, Die Ernährung. Jena, Gustav Fischer. 1913. 8vo. Pp. xxii + 738, 277 text-figures.

There is no telling to what extent our libraries will need enlargement if Professor Jordan carries to completion his encyclopedic "Physiology of Invertebrates," for the 738 pages on Nutrition are to be followed by sections on Respiration, Metabolism, Excretion, Movement, the Nervous System, the Sense Organs and "Psychology."

Excluding the vertebrates, except for the necessary comparisons, and omitting entirely the physiology of reproduction, the plan, as outlined, is to present, with "the greatest unity attainable, a 'biological' treatment of the sum total of the phenomena that make up the life of the individual."

The first installment of this full-grown undertaking begins with a definition of life to which we can not subscribe, and a scene of some comic value in which teleology is shown the door, but asked to leave behind her extremely useful vocabulary. After this follows a systematic treatment of the phenomena of nutrition in all the usual groups of invertebrates, the material under each type or subtype being conveniently divided so that a discussion of the food, together with its modes of capture, always precedes an analysis of the various digestive processes and a discussion of the origin and nature of the involved se-

cretions. These topics in turn are followed by sections on absorption, the elimination of wastes, metabolism, reserve stuffs, and the phenomena of starvation. This list of regulars, now and again is lengthened to accommodate some special structural or functional relation.

Professor Jordan's work inevitably courts comparison with Winterstein's great cooperative handbook, but unfortunately both are incomplete, and the contrast between them in their present state is more apparent than real, for in Winterstein the section on the nutrition of invertebrates is also the product of a single pen. For the present, therefore, the relative merits of team work *versus* individual play in the production of physiological encyclopedias must remain uncertain.

On the whole, Winterstein offers more of immediate interest to the general physiologist, nevertheless, the space devoted by Jordan to comparable sections is nearly the same. Possibly some day some one may read one or the other from cover to cover, but the normal function of each of these books will probably be that of a Thesaurus to be tapped when occasion requires.

Jordan makes access to the wealth of material treated by him more convenient than Winterstein, not only on account of a greater regularity of treatment, but by the employment of heavy-typed captions of various sizes, together with elaborate subject and author indices for which we are not made to wait until the bitter end.

No work of this character ever comes off the ways without its share of misprints, mislabeled figures, misinterpretations, misquotations and sins of omission as well as commission. Numerically most of these types of defect fall well below the average, though one of them is quantitatively as well as qualitatively thoroughly characteristic of the great German text, for it appears to be a law of nature that the mind of the continental bookmaker is selectively impermeable to the efforts of American investigators. This is as true of Jordan as it is of his predecessors, and in consequence there is no group treated by him which here and there could not have been treated a bit better if he had drawn a little on our experience. Considering the numerous phases of nutrition in invertebrates and the number of Americans who have devoted years to the study of special groups, the omission of some of them, or the bare mention of others, shows that our work either does not reach the European, or is not assessed at the value placed upon it here. This may apply justly to some of our work; on the other hand, the discounts levied against certain men who might be mentioned are absurd.

The attempt to cover single-handed a field as large as the physiology of invertebrates is not symptomatic of the age, but the attempt to do so at all certainly is. Whoever knows the highly dispersoid condition of the literature and realizes how largely observation and experiment have been incidents in the work of morphologists and systematists, knows also the value of a reliable inventory of the facts. The importance of this for any special physiology needs no comment, whereas to those who agree with Winterstein that comparative physiology should be an independent science, rather than a method, the whole matter is obvious. However, we may relate special, comparative and general physiology, Jordan's book, like Winterstein's, will do good, but in a somewhat different manner, for it is aimed more directly at teachers of zoology, and for them appears admirably suited.

One of the worst faults of zoological courses on invertebrates is their over-emphasis of structure, a method grounded historically, and based on the belief that the best scientific use to which an organism can be put is to determine its relatives. No doubt this is important, yet how the related things manage to live is also worth knowing. With its well-organized material and superior illustrations Jordan's book shows beautifully how anatomy and physiology can be taught as one subject. "Proofs of Evolution," "Evidences of Relationship" and "Bases of Classification," however, will not readily cede their places, but

much to enliven and augment them will be found in a book which modestly attempts to lay the foundations of a phylogeny of physiological processes. In the concluding chapter occur, among others, generalized summaries of the three principal methods of food intake; an interesting section on salivation with its numerous differentiations; and a phylogeny of the ferments in which trypsin or trypsin-like substances are held to be the oldest. Other matters considered in the final chapter are genetic comparisons of the histological processes involved in secretion and absorption, the fate of absorpta, and finally a discussion of "the liver question," especially interesting to those who question the validity of christening invertebrate organs according as their color, form or location happens to resemble something or other in a vertebrate. This section is summed up in the following paragraph:

"The specialization of a stomach with the secretion of free acid and the necessary pepsin, the formation of special glands, segregated from the digestive epithelium, though pouring their juices into the alimentary tract, the occurrence of a liver correlated with digestion, and finally complicated regulations in the functions of these organs; all this distinguishes the digestive processes of vertebrates from those of invertebrates."

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University of Michigan,
May 13, 1913

Die sanitarisch-pathologische Bedeutung der Insekten und verwandten Gliedertiere, namentlich als Krankheits-Erreger und Krankheits-Überträger. By Emil A. Göldi. Berlin, R. Friedländer & Sohn. 1913. Pp. 155, Figs. 171.

The present small volume which contains a general account of the habits of insects in their relation to diseases is based on material presented by Professor Göldi in a course of lectures which he has been giving for a number of years in the University of Bern.

In spite of its limited size it gives a very good presentation of such facts as can be satisfactorily included in a university course on insects and diseases, and is much better suited for the general student than those portions of the text-books on tropical medicine that are devoted to insects. Its value lies mainly in the fact that the subject is considered primarily from the biological rather than the medical standpoint, and consequently in a more connected and intelligible way for this class of students.

The subject matter is perhaps somewhat different than would be indicated by the title, as much emphasis is laid upon insects which live partly or entirely as parasites of man and domestic animals, to which is added a supplementary discussion of their relation to the transmission of disease. The material is divided into three chapters: first, stinging, biting and caustic insects; second, insects and related Arthropods of parasitic habits; and third, insects and other Arthropods as carriers of disease. The first section is quite fully treated, but the bulk of the text is devoted to the second section, and the third receives rather brief consideration. One might wish that the portion relating to insects as carriers of various infections had been presented in more complete form, but this omission is more apparent than real, for the second chapter contains much material (*e. g.*, the development of trypanosomes) which one might expect to find in the third.

Göldi describes the morphology and physiology of the poison apparatus in the Hymenoptera, scorpions, centipedes and Hemiptera and points out the probable functions of the poison glands in different groups. Thus in the Hemiptera, spiders and centipedes, the so-called poison has apparently been developed as a digestive fluid. He is inclined to believe also that the venom of the scorpion has a digestive function in addition to its poisonous properties. Following this is a discussion of insects, mainly caterpillars of various kinds, that are provided with poisonous bristles or spines which cause irritation to the skin. Numerous species are figured, including a considerable number from equatorial America.

The section devoted to parasitic insects and other Arthropods opens with an account of mosquitoes which covers some twenty pages and contains in addition to general matter much valuable information on the carriers of malaria and yellow fever, and on other mosquitoes of the Amazonian region, based on original observations made by the author. Following this is a similar but shorter discussion of the gad-flies (Tabanidæ), the blood-sucking Muscidæ, Simuliidæ, Chironomidæ and Psychodidæ. The phlebotomic members of these families are spoken of by Göldi as habitual (professionelle) blood-suckers and hemiparasites (Halbparasiten) in distinction of other wholly parasitic forms (Ganzparasiten) which remain on the host during their entire life, or at least during their preparatory stages. Following this is an account of the more highly modified Diptera Pupipara and the fleas, the latter being treated at some length. The sucking lice are briefly mentioned as well as bedbugs and a few other blood-sucking Hemiptera. Ticks and mites follow, the mites receiving by far more space in proportion to their importance as disease carriers. Under the heading of myiasis are described many of the Diptera which develop regularly or occasionally as internal parasites of man and other mammals.

The third chapter on "Insects and Related Arthropods as Carriers of Disease" deals with the distribution and manner of transfer of insect-borne diseases, as well as with the morphology and life-cycles of a number of the causal microorganisms, such as the malarial parasites, trypanosomes, filarias, etc.

The volume is profusely illustrated by 171 text-figures, mainly in half-tone, derived from various sources with a smaller number of original figures. All are well selected, but many are inferior to those in the original works from which they have been copied. Some of the names applied to the insects mentioned are rather antiquated; thus one sees *Lucilia macellaria* and *Musca vomitoria* appearing in the text in place of generic names which have been used for many years. In the description of Fig. 103, representing some North American ticks, there is an unfortunate confusion of names, where *Dermacentor venustus,* the vector of Rocky Mountain spotted tick fever, is referred to as the "gefleckte Texasfieberzecke des Felsengebirges" (Rocky Mountain spotted Texas-fever tick). This species has, of course, no connection with Texas fever of cattle.

The text is well printed, furnished with a good index, and shows only a small number of typographical errors. So far as the reviewer can judge, there are no serious errors of statement, although some parts, such as those on the food and anatomical characters of the larvæ of *Stomoxys calcitrans,* are open to some criticism.

The book is one which may well be placed in the hands of students as a text, and it is to be hoped that its author may later see fit to enlarge it into a more extended treatise.

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SCIENTIFIC JOURNALS AND ARTICLES

IN January, 1913, *The American Mathematical Monthly* passed into the control of an editorial board consisting of representatives of twelve supporting universities and colleges in the middle west, together with B. F. Finkel, founder of the *Monthly* and editor since its inception in 1894.

It is the editorial policy of this journal to appeal especially to teachers of mathematics in the collegiate and advanced secondary fields, not only for the purpose of directing attention to questions of improvement in teaching in these fields, but also to foster the development of the scientific spirit among large numbers who are not now reached by the more technical journals.

A selection from the Tables of Contents of the first six numbers includes articles on—

The History of Mathematics, such as the following:

"History of the Exponential and Logarithmic Concepts," by Professor Florian Cajori, of Colorado College.

"The Foundation Period in the History of

Group Theory,'' by Josephine Burns, graduate student at the University of Illinois.

''Errors in the Literature on Groups of Finite Order,'' by Professor G. A. Miller, University of Illinois.

Pedagogical Considerations, such as the following:

''The 'Foreword' concerning Collegiate Mathematics,'' by Professor E. R. Hedrick, University of Missouri.

''Mathematical Literature for High Schools,'' by Professor G. A. Miller.

''Minimum Courses in Engineering Mathematics,'' by Professor Saul Epsteen, University of Colorado.

''Incentives to Mathematical Activity,'' by Professor H. E. Slaught, University of Chicago.

General Mathematical Information, such as the following:

''The Third Cleveland Meeting of the American Association for the Advancement of Science,'' by Professor G. A. Miller.

''Western Meetings of Mathematicians,'' by Professor H. E. Slaught.

''Notes and News'' of events pertaining to mathematics, under the direction of a committee of which Professor Florian Cajori is chairman.

''Book Reviews'' and announcements of new books in mathematics, under the direction of a committee of which Professor W. H. Bussey, University of Minnesota, is chairman.

Topics Involving a Minimum of Technical Treatment, such as the following:

''Maximum Parcels under the New Parcel Post Law,'' by Professor W. H. Bussey.

''Precise Measurements with a Steel Tape,'' by Professor G. R. Dean, Missouri School of Mines.

''A Direct Definition of Logarithmic Derivative,'' by Professor E. R. Hedrick.

''A Simple Formula for the Angle between Two Planes,'' by Professor E. V. Huntington, Harvard University.

''Two Geometrical Applications of the Method of Least Squares,'' by Professor J. L. Coolidge, Harvard University.

''Problems Proposed and Solved,'' under the direction of a committee of which Professor B. F. Finkel, Drury College, is chairman.

Topics Involving Somewhat More Technical Treatment, designed to stimulate mathematical activity on the part of ambitious students and teachers; for example, such as the following:

''The Remainder Term in a Certain Development of $F(a+x)$,'' by Professor R. D. Carmichael, Indiana University.

''A Geometric Interpretation of the Function F in Hyperbolic Orbits,'' by Professor W. O. Beal, Illinois College.

''Certain Theorems in the Theory of Quadratic Residues,'' by Professor D. N. Lehmer, University of California.

''Some Inverse Problems in the Calculus of Variations,'' by Dr. E. J. Miles, Yale University.

''Amicable Number Triples,'' by Professor L. E. Dickson, University of Chicago.

H. E. SLAUGHT,
Managing Editor

BRANCH MOVEMENTS INDUCED BY CHANGES OF TEMPERATURE[1]

THAT changes occur in the linear dimensions of metals following fluctuations in the temperature is common knowledge, but that similar changes result in wood and living trees is not so generally known. Pure water has its smallest volume at 4° C., and lowering the temperature further increases its volume until it freezes; while ice contracts regularly with decreasing temperature and at a greater rate than any of the metals. It is generally supposed that marked changes in temperature have some effect upon the volume of tree trunks because radical clefts occur so frequently in severe winters and old clefts close during the middle of warm winter days and open again as the temperature sinks during the night. Since freezing water often bursts its container it is popularly held that such tree trunks are burst by the expansion of the freezing water in them. Caspary[2] has shown this

[1] This review of the literature of branch movements and observations grew out of a study of crown-rot of fruit trees and is published separately because it is only indirectly related to the main theme.

[2] R. Caspary, ''Ueber Frostspalten,'' *Bot. Zeit.*, 13: 449–62, 473–82, 489–500, 1855; ''Neue Untersuchungen über Frostspalten,'' *Bot. Zeit.*, 15: 329–35, 345–50, 361–71, 1857.

to be erroneous by calling attention to the facts that ice contracts as the temperature sinks while clefts in tree trunks open farther and farther as the temperature drops, *i. e.*, were the opening of the clefts due to the formation of ice they would close again as the temperature sank lower. As a matter of fact tree trunks begin contracting above the freezing point of water, as may be gathered from Caspary's records given in the above cited papers on the opening and closing of clefts, as well as from direct measurement of circumferences.[3]

According to the figures in text-books of physics changes in the lengthwise dimension of wood due to a change of temperature are only slight as compared to changes resulting in transverse direction. The transverse contraction of wood is given as nearly the same as the linear contraction of ice. It has been suggested that different types of tree tissues contract at different rates and that the branches of trees are caused to move up and down by changes of temperature owing to a differential contraction and expansion of the tissues on the two sides.

The literature of branch movements of trees is rather meager and not generally known, as may be gathered from an article which appeared in 1904, entitled, "An Undescribed Thermometric Movement of the Branches in Shrubs and Trees,"[4] as well as from some recent correspondence with C. C. Trowbridge who has made a study of the subject but had found only Ganong's paper. The earliest published observations and experiments found on branch movements induced by changes in temperature were by Geleznow.[5] He noted that branches of certain trees sink during cold weather and rise again as it becomes warmer. During a thaw branches of linden, birch, elm, and other epinastic species were cut and fixed in horizontal position by their bases, some with their lower sides uppermost; and the position of the tips was marked. As the temperature became lower the inverted branches moved in a direction opposite to that of the branches in normal position, indicating that the direction of movement depends on the make-up of the branches. It was noted, however, that although pine branches are hyponastic and linden branches epinastic, both bend downward as the temperature sinks, showing that the nature of the eccentricity could not be the cause of these movements.

The relative amounts of water contained in the wood of the lower and upper sides of branches gave no convincing results, although it seemed possible that this might have a causal relation to the movement. It was found that the wood on the upper side of pine branches had a greater water content than that on the lower, while in the case of birch and a number of other trees the wood on the underside contained more water than that on the upper. The water determinations were made once each month throughout the year and are interesting aside from any bearing they may have on branch movements. For instance, the bark on the larch was found to contain more water throughout the year than the wood; the wood often contains less water toward the distal end of branches, while the bark usually contains more.

Caspary also made some very interesting observations the year following the studies by Geleznow,[6] although the work was not published until much later. The positions of the ends of convenient branches of ten species of trees were marked on upright stakes driven in the ground and their locations redetermined about sun-up each day from November 29, 1865, to March 24, 1866. Heavy dew and rain were found to cause a slight depression of branches and snow induced considerable sink-

[3] "Crown-rot of Fruit Trees: Field Studies," N. Y. State Agri. Expt. Sta. Technical Bull., 23: 35–39, 1912.

[4] W. F. Ganong, *Ann. Bot.*, 18: 631–44, 1904.

[5] N. Geleznow, "Recherches sur la quantité et la répartition de l'eau dans la tige des plantes ligneuses," *Melanges Biol. Acad. Imper. Sc. St. Petersb.*, 9: 667–85, 1877.

[6] R. Caspary, "Uber die Veränderungen der Richtung der Äste hölziger Gewächse bewirkt durch niedrige Wärmegrade," Internat. Hort. Exhibit Bot. Congress, London, 3: 98–117, 1886.

ing. It was also noted that after a period of rather strong wind the branches drooped much more than was the case in a calm period having the same temperature. But even such influences failed to prevent the rise of branches on the occurrence of low temperature in case of species which normally raised their branches on the coming of cold weather. It was also found that branches were diverted to the right or left on some trees in proportion to the degree of cold. The branches of linden and those of conifers sank with the temperature, while those of *Pterocarya* and *Acer* rose as the temperature became lower. The branches of *Æsculus, Carpinus, Rhamnus* and *Pavia* rose on slight lowering of the temperature and sank when it became colder. The distal ends of the branches on nearly all of the trees under observation stood higher in spring than they did in the preceding fall. The eccentricity of the wood of branches was thought to have no relation to this movement, but it seemed that it might be due to a differential contraction and expansion of the upper and under sides of branches, and it was held that this difference in contraction must be distributed over the entire length rather than being confined to the crotch regions.

Ganong's[7] observations were more limited. He found that branches move or bend upward or toward the axis as the temperature sinks. He reports that the branches had a greater water content during warmer days of winter than during the colder ones and therefore the thermometric movement. According to the determinations by Geleznow the water content of the wood of *Pinus silvestris* reached a minimum in June and a maximum in October, while bark has its maximum in October and its minimum in April. *Acer platanoides* had a maximum water content in the wood in June and a minimum in October; that is, it was found that the minimum water in the wood does not occur in winter, but since his determinations were made monthly they throw no light on the validity of Ganong's inference that the movements depend on periodic variations in the water content. The most recent contribution to this subject is by C. C. Trowbridge.[8] Although only a summary has appeared as yet it promises to be of interest not only because of its content, but also on account of the fact that it is from the physicist's standpoint. Owing to its brevity this summary as given in the proceedings of the Torrey Botanical Club is quoted here in full:

> (1) That branch movements occur in certain trees, due to temperature changes below the freezing point of water, and that in certain other trees no movement whatever has been observed. (2) That the movements amount to as much as 3 or 4 ft. differences in the distance from the ground to the ends of certain curved branches which are in length of the order of 20 ft., these changes occurring through a range of 30 degrees below freezing. (3) That little, if any, movement takes place above freezing point of water, and that the movements begin soon after the temperature remains at this point for several hours. (4) That there is a considerable lag in the movement of the branches behind the temperature changes, although a difference in the rate of change of temperature is followed at once by a difference in the rate of change of the position of the branches. (5) That the movements are practically of equal magnitude in December, January and February, that is, the seasonal change is not a ruling factor in this movement.

According to Geleznow, then, tree branches may move either up or down as the temperature sinks. He found that eccentricity of the wood is not correlated with this movement, but that a difference in the water content of the wood on the upper and under sides of branches seems to be, yet he did not consider that an explanation of the movements but only a suggestive parallel. Caspary found three classes of trees in regard to the manner of branch movements: In one class the branches sink and in another they rise on lowering of the temperature and in the third class the branches rise as the temperature is lowered slightly but sink when it gets still colder. According to him the movements of branches result from a differential contraction of the

[7] *Loc. cit.*

[8] "Branch Movements of Certain Trees in Freezing Temperatures," *Torreya*, 13: 86–87, 1913.

under and upper sides of branches. These two investigators agree as to the main groups of trees in respect to the effect changes of temperature have on the position of their branches. It seems, therefore, that Ganong happened to use trees and shrubs which belonged to only one of these classes. The explanation advanced by Caspary is suggestive because it is based on a differential longitudinal contraction of the wood in branches. Some of his earlier studies[9] have shown that tree trunks undergo transverse contraction in proportion to the degree of cold and that the assumptions to the contrary are incorrect. That longitudinal contraction of wood takes place as the temperature is lowered is upheld by many general observations. Trees are frequently cleft in forks of the trunk during winter and these clefts open when it gets cold and close as warmer weather comes. In another connection the writer found that

> crotch clefts were always at right angles to the branching and usually widest above, appearing as though the crotches had been split by driving in a thin wedge from above. In two instances where measurements were taken the component parts of the crotches had separated about 2 cm., which seems to indicate that there had also been a longitudinal contraction of the outer portions of the trunks, thus resulting in an outward bending of the branches.[10]

Caspary's observations on the lateral displacement of some tree branches also fit into his contraction theory, although he failed to note it, provided it is assumed that the trees on which this movement occurred had trunks with the so-called twisted grain, for in such a case longitudinal contraction would necessarily result in lateral movement of the attached branches.

In this connection it seems of interest to notice some of the peculiarities of arrangement of the tissues about the bases of branches that were studied by Jost.[11] He found that the cambium at the basal angles of branches is not eliminated as the stems and branches grow in diameter, but that its cells and those of the tissues differentiating from the cambium glide between each other and also become shorter. In case of the adaxile side crowding and compression are more marked than on the abaxile side, apparently because the angle is usually much smaller. Sometimes the bark in the adaxile angle is not forced outward, but is included, and under such conditions the pressure in the angle compels the cambium under the included bark to cease growth. Most commonly, however, the wood-growth in the angle forces the bark outward and thereby induces a more rapid reduction in the cambial area and a greater increase in thickness per annual ring than on the abaxile side. In addition to gliding between each other, the cells in the adaxile side are turned at a tangential angle so that large groups of them come to lie almost horizontal or at right angles to the axis, while groups of cells from the branch and from the stem sides are forced in among these transverse cells of the crotch. Usually, then, no cambial cells are eliminated in branch-angles, but they are forced between their neighbors and complicated tangles result in which often large groups of cells come to lie in a more or less transverse direction. The ends of medullary rays vertical to each other in the base of branches come closer together and may even cross each other.

In view of the fact that the groups of partially transverse tissues at the base of a branch are probably under more or less pressure and because changes of temperature have a much greater effect upon transverse than upon longitudinal dimensions it seems possible that the differential contraction which according to Caspary is the cause of the thermometric branch-movements may be chiefly confined to the bases of branches and depend upon these peculiar gnarly growths described by Jost, and perhaps their arrangement about the base of a branch which is usually characteristic for a species, may determine whether a branch shall move up or down as the temperature sinks. The relative amounts of "spring" and "summer" wood in the under and upper sides

[9] *Loc. cit.*

[10] *Loc. cit.*, pp. 36–37.

[11] L. Jost, "Ueber einige Eigenthümlichkeiten des Cambiums der Bäume," *Bot. Zeit.*, 59: 1–24, 1901.

of annual rings at the bases of branches may also have a possible relation to the movements. At any rate, it seems more promising to seek for some anatomical differences between the upper and under sides of branches as the cause of the movement than to study their water content.

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SPECIAL ARTICLES

"YELLOW" AND "AGOUTI" FACTORS IN MICE

SOME time ago Mr. A. H. Sturtevant[1] suggested the hypothesis that there is negative coupling between the "yellow" and the "agouti" factors in mice. At that time[2] I offered certain facts which appeared to me to give evidence contradictory to the hypothesis which he advanced.

I included in this evidence the data offered by certain matings of mice made by Miss F. M. Durham.[3] It now appears that I misunderstood the true meaning of her tables, which were somewhat ambiguous, and that accordingly the only remaining evidence which I possessed against Mr. Sturtevant's hypothesis was afforded by the results of certain matings which I made about five years ago.

It seemed, therefore, advisable to make crosses calculated to test his hypothesis with the stock which I have at present on hand.

The first of these matings was between wild agouti mice and yellow mice which did not carry the agouti factor. To use Sturtevant's terminology these individuals were as follows:

Yellows—*Yt yt*,
Agouti—*yT yT*.

Two sorts of individuals, yellow and agouti, are expected in equal numbers from such matings. The actual results were 14 yellow, 28 agouti. The yellows should on Sturtevant's hypothesis be of the formula *Yt yT* and form only two sorts of gametes *Yt* and *yT*. Such yellows should by any non-yellow animal, or when mated *inter se*, give only two sorts of young, yellow and agouti. Actually they produced 23 yellow and 18 agouti young.

Thinking that possibly the *black* factor might be necessary to obtain such a result, I mated three homozygous dilute brown agouti animals with a single brown-eyed yellow (carrying no agouti). All these animals lack the factor for black. The first generation gave 11 yellows and 5 brown-agoutis. The yellows were then crossed with dilute *brown* animals which did not possess the factor for agouti. If according to Sturtevant's hypothesis there was negative coupling or repulsion between the yellow and agouti factors there would be only yellow and agouti young from such a mating. If, on the other hand, these factors were entirely independent we should have non-agouti young as well. The results follow.

	Yellow	Dilute Yellow	Brown Agouti	Dilute Brown Agouti	Brown	Dilute Brown
Observed	31	34	24	27	0	0
Expected by Sturtevant's hypothesis	29	29	29	29	0	0
Expected by independent recombination	28.5	28.5	14.2	14.2	14.2	14.2

The conclusion is obvious that the factors for yellow and agouti are unable to go into the same gamete. On the other hand, the factors for "density" and "dilution" of pigmentation show no such relation to any other factors.

Since I have no reason to doubt the authenticity of the contradictory cases, in my own work, to which I have already referred, it seems probable that the factors for "yellow" and "agouti" are not absolutely incompatible, but that they may in rare cases occur in the same gamete. As a general thing, however, it seems that Sturtevant's hypothesis is correct and that a negative association exists between these two factors.

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[1] Sturtevant, A. H. (1912), *Am. Nat.*, Vol. 46, pp. 368–371.

[2] Little, C. C. (1912), *Am. Nat.*, Vol. 46, pp. 491–493.

[3] Durham, F. M. (1911), *Journal of Genetics*, Vol. 1, pp. 159–178.

ANTIGRAVITATIONAL GRADATION

NOWHERE on the face of our globe, we now know, are the effects of the gradational processes so completely or so conspicuously exemplified as on the broad intermont valleys of arid regions. There the graded plain is the dominant feature of landscape. It attains a degree of perfection that is wholly unknown elsewhere. It is more even than is theoretically demanded of the ideal or finished peneplain. It is, as Passarge astutely remarks, smoother than any peneplain possibly can be. Yet never has relief element been so generally misunderstood or so entirely overlooked.

In the course of the wide discussion which the subject recently has aroused in almost every land it is fortunate that so many localized illustrations have been so carefully described. For the first time we are now able to cite definite references. The present aspect of the theme centers around the topic of local dissection and terracing of the steeper slopes immediately encircling many desert mountain ranges—the belt designated by physiographers as the *bajada,* the title being an adapted Spanish name.

The remarkable phenomenon of bajada-terracing does not appear, as urged by Salisbury, to be a necessary consequence of the general lowering of the highland by stream-action while the intermont lowlands are being filled up, because some of the best examples of terracing border broad plains having rock-floors. For the same reason it does not appear possible that there ever occurs during so-called topographic maturity an adjustment by water-actión between one bolson and another adjacent but lower one which results in the terracing of the higher, as suggested by Davis. There is little or no evidence to show that bajadas were all formed during periods of glaciation, as advocated by Barrell, since some of the most typical forms of this class are found surrounding low knolls near sea-level and far below all possible altitudes of glacial action in the region. Neither does it seem likely that bajadas were constructed during interglacial epochs of materials which accumulated in the mountains when the latter were covered by ice, as argued by Huntington, for this does not explain the many bajada-belts with rock-floors. Nor is it any better to postulate a recent increase of temperature and a different distribution and amount of rainfall abetted by the advancement of the area in the geographic cycle, as proposed by Visher, for the terracing is now going on before our very eyes at an astonishingly rapid rate, and as quickly is it also completely obliterated.

Terracing of desert tracts appears to be confined mainly to the foots of the loftier ranges; and its accomplishment is fully described elsewhere. Under the ordinary conditions of deflative action we would expect the locus of maximum lowering to take place in the middle part of the bolsons. According to this recognition of conditions eolic erosion necessarily operates from the lower to a higher elevation. As shown by Professor Davis, the winds in their action are not dependent like water on the gradient of the land surface for their gravitational acceleration; they may blow violently and work effectively on a perfectly level surface. Unlike water they may also erode vigorously up-hill; and this is exactly what they manifestly and constantly do on the bolson-plains.

Notwithstanding the fact that wind erosion operates both up and down the slope there is, owing to the peculiar configuration of each basin-shaped tract, a preponderance of effect on the up-slope part of the course. There also appears to be a limit to the gradient on which the wind is able to blow sands erodingly and extensively up-hill, and this limit seems to lie chiefly between a two and a four per cent. gradient. It is for this reason seemingly that the intermont plains are so smooth, so uniform in grade, so high in gradient. Eolic gradation thus mainly works from a lower to a higher level. The direction of greatest activity is directly opposite that of stream-work. It is mainly up-hill.

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